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Naval Science For The Merchant Marine Officer

Although the words "he," "him," and "his" are used sparingly in this manual to enhance communication, they are not intended to be gender driven nor to affront or discriminate against anyone reading *Naval Science for the Merchant Marine Officer*, NAVEDTRA 38051.

PREFACE

Naval Science for the Merchant Marine Officer has been prepared for use by the Departments of Naval Science at state maritime academies. This textbook is oriented toward Merchant Marine Reserve Officer candidates—not Naval Officer candidates. The student will be introduced to the mutual dependence of the Navy and Merchant Marine in accomplishing their common seapower objectives. In addition, fundamental information is presented on unique procedures utilized by the Merchant Marine when operating in logistic support of military forces, in a controlled shipping environment, and in hostile action. The overall objective is to prepare the merchant officer to carry out his responsibilities aboard merchant ships or at related shoreside activities. To maximize the effectiveness of this text it is recommended that it be used in conjunction with *To Use the Sea* (Naval Institute Press) and *Allied Guide to Masters* (ACP-148).

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THE UNITED STATES NAVY

GUARDIAN OF OUR COUNTRY

The United States Navy is responsible for maintaining control of the sea and is a ready force on watch at home and overseas, capable of strong action to preserve the peace or of instant offensive action to win in war.

It is upon the maintenance of this control that our country's glorious future depends; the United States Navy exists to make it so.

WE SERVE WITH HONOR

Tradition, valor, and victory are the Navy's heritage from the past. To these may be added dedication, discipline, and vigilance as the watchwords of the present and the future.

At home or on distant stations we serve with pride, confident in the respect of our country, our shipmates, and our families.

Our responsibilities sober us; our adversities strengthen us.

Service to God and Country is our special privilege. We serve with honor.

THE FUTURE OF THE NAVY

The Navy will always employ new weapons, new techniques, and greater power to protect and defend the United States on the sea, under the sea, and in the air.

Now and in the future, control of the sea gives the United States her greatest advantage for the maintenance of peace and for victory in war.

Mobility, surprise, dispersal, and offensive power are the keynotes of the new Navy. The roots of the Navy lie in a strong belief in the future, in continued dedication to our tasks, and in reflection on our heritage from the past.

Never have our opportunities and our responsibilities been greater.

CONTENTS

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Text Edited By
L. THOMAS C. OFFUTT, USN

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CHAPTER 1

MERCHANT MARINE RESERVE, U.S. NAVAL RESERVE

BACKGROUND

A close and mutually supportive relationship between the Navy and the merchant marine has been traditional since the American Revolution. The Merchant Marine Reserve, U.S. Naval Reserve (MMR, USNR) Program is intended to reinforce that relationship.

The U.S. Navy evolved out of the American merchant marine. Practically every naval officer in the American Revolution was an experienced merchant mariner. The Navy's first fighting ships were primarily merchant vessels with guns installed. Our first six frigates, authorized by Congress on March 27, 1794, were commanded by ex-merchant mariners. Officers and midshipmen of the early U.S. Navy were encouraged to sail on merchant vessels to gain additional seagoing experience and improve their nautical skills. Until World War II, officers and men trained in the merchant marine formed the most important manpower reserve for the Navy.

In World War I licensed merchant officers joined the Naval Auxiliary Service of the Naval Reserve assisting the Navy in either the Cruiser and Transport Service or the Naval Overseas Transportation Service. Both of these agencies were manned by merchant marine officers. They transported about two million soldiers and 60 percent of the supplies sent to allied forces in World War I.

With the Second World War threatening in Europe and Asia, Congress enacted the Merchant Marine Act of 1936. Its primary purpose was to establish a strong merchant marine capable of service as a naval auxiliary in time of war or national emergency. Qualified officers in the merchant marine joined the Naval Reserve Officers Corps as the likelihood of war increased. During World War II, the merchant officers holding naval reserve commissions served our country valiantly. Proportionally, their losses due to hostilities exceeded those of the U.S. Navy in World War II. The government, recognizing the dedication and sacrifice of the merchantmen serving in the war zones, paid special bonuses to them for their contribution to the national effort under such hazardous conditions. The same bonus concept held true during the Korean and Vietnam conflicts.

Today the U.S. Navy has substantially fewer ships than it did at the end of World War II. One of its primary missions, however, has not changed—that of protecting the sea lanes vital to the nation in time of war. To accomplish this mission with fewer ships, the Navy is working closer with the merchant marine than ever before during peacetime. Merchant tankers and cargo ships are routinely training with the supporting naval fleet operations, and the dialogue between merchantmen and naval personnel is increasing as we work together.

As our country's demand for critical raw materials keeps rising, the role of the U.S. merchant marine to transport these materials and the Navy's mission to keep the sea lanes open for our merchant ships become increasingly vital.

The merchant marine officer's participation in the Merchant Marine Reserve, U.S. Naval Reserve Program is greatly needed to build and strengthen the natural bond between our companion sea services—the U.S. merchant marine and the U.S. Navy.

In 1979 Secretary of the Navy W. Graham Claytor, Jr., announced the expansion of a program designed to increase mutual support and interface between the U.S. merchant marine and the U.S. Navy by providing specialized naval training for qualified merchant marine officers who are either ashore or on board U.S. merchant ships. The current Merchant Marine Reserve, U.S. Naval Reserve program became effective March 1, 1979. The program allows commissions in the Naval Reserve for qualified merchant marine officer, such as graduates of the merchant marine academies. Other eligible merchant marine officers may receive direct commissions and appointments into the program.

onsored by the Chief of Naval Operations, ogram is administered by the Commander Reserve Forces (COMNAVRESFOR) in rough Naval Reserve officer representatives jor U.S. port cities.

THE PURPOSE OF THE MERCHANT MARINE

e Merchant Marine Reserve, U.S. Naval ve Program was the result of extensive sions and planning between the Assistant ary of Commerce for Maritime Affairs and ief of Naval Operations, in support of the ation of Policy in Title I of the Merchant e Act of 1936 (amended) "That the United shall have a merchant marine. . .capable ing as a naval and military auxiliary in time or national emergency."

ON

e Merchant Marine Program provides a uing source of well-qualified merchant e officers whose naval and professional pment within the program will enhance ant marine-Navy coordination in time of national emergency, or war. The program d on Department of the Navy policy that fficers will not be recalled involuntarily to duty in the Navy during a national ency or in time of war. Instead, they will ue to serve aboard merchant ships in their licensed employment and use their Navy g in coordination with the fleet.

et commanders have increased their re- ents and reliance on merchant ships to such ent that "interface" is now a proper and ary role in the readiness of U.S. naval and ant marine forces. At the heart of that ess is the ability of individual Merchant e Reserve officers trained in naval science val procedures to operate effectively in ction with military forces.

neral Order Number 87 of Title 46 of the ode of Federal Regulations requires that nts to the state and federal maritime nies must "agree in writing to apply ppropriate time before graduation, for a ssion as ensign in the U.S. Naval Reserve accept such commission if offered." U.S. students must complete the naval science at their respective institutions as a tion requirement.

ORGANIZATION

The Merchant Marine Reserve, U.S. Naval Reserve Program takes into account the unique nature of the merchant marine profession; accordingly, the structure and operation of the program are significantly different from previous reserve programs. The program sponsor/technical manager is the Strategic Sealift Division (OP-42) Deputy CNO for Logistics (OP-04), Office of the Chief of Naval Operations. The primary administrative authority for the program and participating officer is the Commander Naval Reserve Forces (COMNAVRESFOR) in New Orleans. Within COMNAVRESFOR the program organization consists of two elements, as follows:

1. A Merchant Marine Individual Ready Reserve Group (MMIRRG) is established within COMNAVRESFOR to provide a central management function for Merchant Marine Reserve officer training and records. The point of contact is the Merchant Marine Reserve Program Manager at Commander Naval Surface Reserve Force (Code 3133) located in New Orleans.
2. Merchant Marine Reserve Operational Headquarters (MMROCH) Units are established at the following sites within Naval Reserve Readiness Commands:

   a. MMROCH Unit 0102, New York, N.Y., will provide coordination and liaison for MARAD's Eastern and Great Lakes Regions.
   b. MMROCH Unit 0206, Washington, D.C., will augment MARAD's Headquarters in Washington, D.C., and provide liaison and coordination to MARAD in Washington, D.C.
   c. MMROCH Unit 0310, New Orleans, La., will provide liaison and coordination for MARAD's Central Region.
   d. MMROCH Unit 0420, San Francisco, Calif., will provide liaison and coordination for MARAD's Western Region.

Officers in these units will be available for counseling, recruiting, and retention of merchant marine officers in the program; coordination of special training projects to be accomplished by participating officers for Naval Reserve retirement credit; and for liaison with the maritime industry, union, and maritime training schools for enhancement of the Merchant Marine Reserve, U.S. Naval Reserve Program (MMR, USNR).

ELIGIBILITY

All merchant marine deck, engineering, communication, and deck/engineering officers sailing on their license, who hold Naval Reserve commissions in an active status and possess a designator code of 11XX, 162X, 166X, 167X, and 169X are eligible for participation in the Merchant Marine Reserve, U.S. Naval Reserve Program. Additionally, it is possible to obtain a Naval Reserve commission through direct appointment in the Merchant Marine Reserve, U.S. Naval Reserve.

The direct appointment option is designed for merchant marine officers who follow the sea as a profession and who sail on their license for at least four months every two consecutive years.

TRAINING

Training opportunities in the program will provide participating merchant marine officers a combination of professional maritime subjects as well as naval science, administrative, and operational subjects beneficial to career development and professional ability. Especially noteworthy are opportunities to keep abreast of everchanging technology and enhance promotion opportunities and earn Naval Reserve retirement credits concurrently as part of the nation's national defense and security team. There are three principal means of training for members of the MMR, USNR.

Annual Active Duty for Training

A minimum of 12 to 14 days' active duty for training each year is required unless waived by the Commander Naval Reserve Forces. This training duty may be performed on Navy ships, in Navy and maritime industry schools, or on selected staffs afloat and ashore.

The Navy has many different types and classes of ships. In requesting shipboard active duty for training (ACDUTRA), you may state your preferences in broad terms. These preferences might be as follows:

1. Type of propulsion plant (nuclear, steam turbine, gas turbine or diesel)
2. General ship category (combatant—aircraft carriers, cruisers, destroyers, and frigates)
3. Underway replenishment (fleet oilers, ammunition ships, and so forth)
4. Amphibious warfare (amphibious cargo ships, amphibious assault ships, tank landing ships)
5. Auxiliary (repair ships, salvage ships and ocean tugs)

In addition to Navy ships, Merchant Marine Reserve officers may be assigned to Military Sealift Command (MSC) fleet support ships. The Navy also operates several shipyards around the country. ACDUTRA at a naval shipyard would afford you the opportunity to learn ship repair techniques first hand.

The Merchant Marine Reserve Program Manager, Commander Naval Surface Reserve Force (Code 3133) maintains a list of applicable Navy and MSC schools that you may attend when space is available. Typical schools of interest include the following:

- Underway Replenishment
- Naval Control of Shipping
- Convoy Staff Officer
- Damage Control
- Firefighting
- Search and Rescue
- Navy Hydraulics
- Antisubmarine Warfare
- Amphibious Warfare Indoctrination and Planning
- Emergency Shiphandling
- Communications
- Engineering
- Ship Repair
- Salvage

A fourth type of ACDUTRA would be assignment to a shoreside fleet support staff or a general shore duty billet. These assignments include but are not limited to the following:

- Military Sealift Command Staffs
- Naval Control of Shipping Organization
- Naval Reserve Readiness Commands
- Port Services

- Fleet Staffs
- Administrative Type Command Staffs
- Shore Intermediate Maintenance Activities

Ashore Participation

Merchant Marine Reserve officers, whose sailing schedule permits, may participate with other Naval Reserve programs. They should submit a Drill Participation Authorization (DPA) letter to the Commander, Naval Reserve Forces requesting temporary assignment to an appropriate Naval Reserve unit that is closest to their location and able to provide the training required.

Correspondence Courses

All participating merchant marine officers may pursue relevant Navy correspondence courses for training and retirement point credits.

ACDUTRA BENEFITS

During your annual active duty for training you will receive full pay and allowances based on your rank and years of service. Additionally, you will be reimbursed for travel to and from the location of your training. After completing your first 12 days of ACDUTRA, you will become eligible to receive a one-time $300.00 uniform allowance.

Nonmonetary benefits will include medical care and a $35,000 SGLI policy, both of which are effective while you travel to and from active duty as well as during the period of training.

Over and above all of this, you will be able to use the full range of base facilities wherever you are stationed. Your dependents, regardless of their location, can be authorized commissary and exchange privileges when your active duty for training is longer than 72 hours.

PROMOTION

Merchant Marine officers participating in the program will compete for promotions only with fellow program participants with special restricted line designators (16X5). They will not compete with members of other Naval Reserve programs, which will be a significant advantage for the U.S. Merchant Marine Reserve, U.S. Naval Reserve officer.

RESPONSIBILITIES

You, as a Merchant Marine Reserve officer commissioned under the provisions of this program, will sign a Training and Service Agreement (figure 1-1) that will require you to complete one of two sailing options (discussed below), to perform two weeks of active duty for training each year of your obligation years, and to submit an annual report.

Sailing Options

The first option requires that you sail on your Coast Guard license at sea for at least four months during every two complete consecutive anniversary years of your obligation following the acceptance of your commission unless the requirement is waived by the Chief of Naval Personnel. In addition, you must apply for and perform at least two weeks of active duty for training (ACDUTRA) during every complete anniversary year of your obligation following the acceptance of your commission unless the requirement is waived by the Commander Naval Reserve Forces.

"Sailing on Your License" is defined as any sailing billet aboard an American flag vessel that requires the use of the United States Coast Guard issued license. This includes licensed positions or positions commensurate with licensed positions aboard oceangoing vessels, self-propelled barges, tugs, dredges, research vessels, and trawlers. No restriction is imposed in relation to horsepower, tonnage, or sailing waters (for example, high seas, the Great Lakes, or inland waters). Attendance at schools or technical training that directly affects the upgrading of the license and/or is required by an employer to improve professional proficiency in the billet is also creditable as "sailing time."

Service on U.S. flag registered oil rigs, requiring a Third Mate's or Third Assistant Engineer's license, will generally satisfy the Training and Service obligation "to sail on your license." Note that many of the rigs are mobile to some degree, but some are not. Oil rigs or platforms that are fixed do not qualify for sailing on your license. The Commander of Naval Reserve Forces will use your written inputs in determining whether you have fulfilled the sailing requirements of the Training and Service Agreement.

Time served as an able-bodied seaman or time served on a foreign flag vessel is not creditable toward time in fullfilling the options with the

(Type or print full name) (Social Security No.)

Having volunteered for training in the Merchant Marine Reserve, United States Naval Reserve Program under the provisions of the Maritime Education and Training Act of 1980 (Public Law 96-453), at one of the State Maritime Academies, Colleges, or Schools.

1. I agree and understand that:

a. I must apply for, and accept if offered, an appointment as Midshipman, USNR and concurrent enlistment in the USNR (inactive); and,

b. The Secretary of the Navy may release me from my obligation under this agreement and terminate my appointment as Midshipman, USNR at any time if in the opinion of the Secretary, the best interests of the naval service require such action; and

c. I must register with the Selective Service Registration Representative, if required under the Military Selective Service Act (MSSA); and,

d. I must complete the course of instruction at the academy, unless separated by the academy; and,

e. I must fulfill the requirements for a license as an officer in the merchant marine of the United States within three (3) months of my graduation from the academy; and,

f. I must maintain a license as an officer in the merchant marine of the United States for at least six (6) years following the date of graduation from the academy; and,

g. I must apply for, and accept if tendered, an appointment as a commissioned officer and serve in the United States Naval Reserve or any other Reserve component of an armed force of the United States, for at least eight (8) years following the date of graduation from the academy; and,

h. I must serve the foreign and domestic commerce and the national defense of the United States for at least three (3) years following the date of graduation from the academy:

(1) As a merchant marine officer serving on vessels documented under the laws of the United States or on vessels owned and operated by the United States or by any State or Territory of the United States; or

(2) As an employee in a United States maritime-related industry, profession, or marine science (as determined by the Secretary of Transportation), if the Secretary of Transportation determines that service under subparagraph (1) is not available to me; or

TRAINING AND SERVICE AGREEMENT
MERCHANT MARINE RESERVE, USNR
(STATE MARITIME ACADEMIES/COLLEGES/SCHOOLS)
CNET Form 1534/3 (Rev. 6-84)

284.55

Figure 1-1.—Training and Service Agreement for Merchant Marine Reserve.

(3) As a commissioned officer on active duty in an armed force of the United States or in the National Oceanic and Atmospheric Administration; or

(4) By combining the service specified in subparagraphs (1), (2), and (3); and,

i. I must report to the Secretary of Transportation on compliance to this paragraph.

j. If the Secretary of Transportation determines that any individual who has attended the academy for not less than two (2) years has failed to fulfill the requirements of paragraph 1d, such individual may be ordered by the Secretary of the Navy to active duty in the United States Navy to serve in an enlisted status for a period of time not to exceed four (4) years. In cases of hardship, as determined by the Secretary of Transportation, this paragraph may be waived; and,

k. If the Secretary of Transportation determines that any individual has failed to fulfill the requirements of 1e, f, g, h, or i, of this agreement, such individual may be ordered to active duty to serve a period of time not less than four (4) years and not more than the unexpired portion (as determined by the Secretary of Transportation) of the service required in subparagraph h above. The Secretary of Transportation, in consultation with the Secretary of Defense, shall determine in which service the individual shall be ordered to active duty to serve such period of time. In cases of hardship, as determined by the Secretary of Transportation, this paragraph may be waived.

2. Immediately following the completion of my required training and having volunteered for appointment as a commissioned officer in the Merchant Marine Reserve, United States Naval Reserve, I hereby acknowledge and understand that:

a. (1) A commission as a Reserve officer of the United States Navy is held at the pleasure of the President; and,

(2) Upon acceptance of a commission, I will be required to serve at least eight (8) years as a Reserve officer in the United States Navy from my date of appointment to a commissioned grade; and,

(3) Any portion of this eight-year period not served on active duty will be served on inactive duty; and,

(4) A resignation of my commission as a Reserve officer submitted prior to completion of this eight-year period will normally not be accepted and, after this period, may be accepted or rejected by the President as the needs of the service may then require; and,

b. Upon acceptance of a Naval Reserve commission: I will be a member of the Merchant Marine Reserve, United States Naval Reserve. As such I agree and understand that:

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Figure 1-1.—Training and Service Agreement for Merchant Marine Reserve—Continued.

(1) I will be a member of the Ready Reserve (USNR-R).

(2) I will sail on my license at sea for at least four (4) months during every two (2) complete consecutive years following the acceptance of my commission unless such requirement is waived by the Chief of Naval Reserve.

(3) I will forward appropriate sailing documentation to the Chief of Naval Reserve within thirty (30) days after the completion of every complete year following the acceptance of my commission.

(4) I will apply for and perform at least two (2) weeks of active duty for training (ACDUTRA) during every complete year following the acceptance of my commission unless such requirement is waived by the Chief of Naval Reserve.

(5) I will have no monthly participation requirements while a member of the Merchant Marine Reserve, United States Naval Reserve, but I may enroll in and complete Navy correspondence courses, complete special assignments, or participate with designated Naval Reserve units to earn retirement credit.

c. If I fail to fulfill all the requirements of subparagraph (b) above during any two (2) complete consecutive years following the acceptance of my commission, my membership and designator in the Merchant Marine Reserve, United States Naval Reserve may be terminated. I acknowledge that such termination may result in changing my designator to 1105 (unrestricted line) in the Ready Reserve, if qualified, or another designator in the Ready Reserve for which I may apply and be qualified. I further acknowledge that a change of designator may subject me to additional training requirements unless waived by the Chief of Naval Reserve.

d. My membership in the Ready Reserve (USNR-R) may be terminated in accordance with law.

e. Should I fail at any time to fulfill all the requirements of this agreement I will be subject to call to active duty, transfer to the Standby Reserve (USNR-S2), retirement, or discharge, as appropriate.

f. Sections 671a and 671b of Title 10, United States Code, currently provide as follows:

671a. Members: service extension during war. Unless terminated at an earlier date by the Secretary concerned, the period of active service of any member of an armed force is extended for the duration of any war in which the United States may be engaged and for six months thereafter.

671b. Members: service extension when Congress is not in session.

(a) Notwithstanding any other provision of law, when the President determines that the national interest so requires, he may, if Congress is not in session, having adjourned

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Figure 1-1.—Training and Service Agreement for Merchant Marine Reserve—Continued.

sine die, authorize the Secretary of Defense to extend for not more than six months enlistments, appointments, periods of active duty, periods of active duty for training, periods of obligated service, or other military status, in any component of the Armed Forces of the United States, that expire before the thirtieth day after Congress next convenes or reconvenes.

(b) An extension under this section continues until the sixtieth day after Congress next convenes or reconvenes or until the expiration of the period of extension specified by the Secretary of Defense, whichever occurs earlier, unless sooner terminated by law or Executive order.

g. Federal statutes and pertinent regulations applicable to personnel in the United States Navy may change without notice and such changes may affect my status as a Midshipman, MMR, USNR, or commissioned officer and obligations to serve as such.

3. I further acknowledge that: My appointment as Midshipman, USNR, will be terminated on the day preceding; appointment to a commissioned status, date of disenrollment from the academy, or other reason for discontinuance of training.

4. I have read and completely understand the meaning and contents of the above. No promises, either written or oral, have been made to me in connection with my application for appointment as a Midshipman or commissioned officer in the United States Naval Reserve except as specified above. I acknowledge receipt of a copy of this document.

Signature Date	Signature Date
Full printed or typed name of witness	Full printed or typed name of applicant

Privacy Act Notification

Under the authority of 5 USC 301, the use of identifying data on this form pertaining to you such as name, date of birth, and social security number will be used for identification purposes while a member of the MMR, USNR Midshipman Program. This information will be maintained in official Navy records and will not be divulged without your written authorization to anyone other than officials or offices involved with this program. You are not required to provide this information; however, failure to do so may result in your not being selected for the MMR, USNR Midshipman Program.

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Figure 1-1.—Training and Service Agreement for Merchant Marine Reserve—Continued.

following exception. Only the first year of your obligation may be satisfied by time spent at sea as an able-bodied seaman aboard an American flag vessel. The "apprenticeship" must be a company requirement for advancement to a licensed position. If you are forced to sail as an AB because of the lack of licensed positions or for other reasons which do not directly lead to advancement to a licensed position, you are not satisfying your obligation. If necessary, you may apply for a waiver.

Sailing for longer than the required four months will not affect future sailing time. Extra time during each two year period does not reduce your obligated sailing time later on.

It is possible to delay your sailing obligation for a maximum of one year. A waiver of sailing obligation must be requested in writing from the Commander Naval Reserve Forces. The decision to grant or refuse a waiver is based on a criterion of inconvenience to you. Suppose a graduate student failed to complete the two weeks of ACDUTRA immediately after graduation from the Academy. He or she found that the spring school schedule would take him or her up to or beyond the anniversary date, thus precluding participation in any reserve training during the first anniversary year. A waiver may be granted in this situation to enable the student to postpone his or her obligation until the first summer recess. Under other circumstances, decisions are made on an individual basis upon receipt of the written request. A waiver is not a cancellation of your obligation, but only a postponement. In effect the granting of a waiver adds a one-year extension to your sailing option.

The second option you have is to apply for active duty in the Navy. The minimum period of time that you serve is currently three years.

While on full time active duty you will be assigned an 1165 designator (unrestricted Naval Reserve Line Officer) unless you are in an aviation or submarine program. Upon release from active duty you will be redesignated as a Restricted Line 16X5 Merchant Marine Reserve Officer.

RETIREMENT

Members of the MMR/USNR may qualify f retirement pay and privileges by completing years of "Qualifying Service." After reaching a 60, qualified reservists begin receiving retireme pay and other benefits.

Eligibility

To be credited with a year of qualifyi service for retirement purposes, a naval r servist must earn a minimum of 50 retireme points each year in his or her anniversa year.

An anniversary year for Naval Reserve offic runs for 12 months from the date the individu was commissioned a USNR officer, assuming break in USNR service. An anniversary year which fewer than 50 points are accumulated do not count toward completing a qualifying year service, but the points are credited toward to retirement point credit.

Retirement points are earned by active du or ACDUTRA (one point/day), authorized dril activities (one point/drill) or, completion correspondence courses (points vary depending the length of the course). All participating rese ists receive 15 points gratuitously for each y of membership.

Retirement Benefits

Upon reaching age 60, retired reservists rece retirement pay based on the highest rank achiev and the total number of retirement points earn Medical care is available free of charge, includi hospitalization and pharmaceuticals for retir and their dependents. Other privileges of rese retirement include the use of all base facilities any Armed Forces installation worldwide a space-available transportation at a nominal c aboard military aircraft.

A summary of the Merchant Marine Rese Program is contained in figure 1-2.

Designator:

Deck License	—MMR, USNR 1625
Dual License	—MMR, USNR 1665
Engineering License	—MMR, USNR 1675
Communications Officer	—MMR, USNR 1695

Obligations after commissioning:

a. Six years total service
b. Submit an annual written report
c. Complete 1 of 2 sailing options below

Sailing Options:

1. Sail on a Coast Guard license on a U.S. flag vessel for at least 4 months out of each consecutive two year period and perform two weeks active duty for training per year for six years.
2. Serve on full time active duty in the Navy or Coast Guard for three years and then sail on a Coast Guard license on a U.S. flag vessel for at least 4 months out of each consecutive year period for the remaining 3 years and perform two weeks active duty for training per year until completion of your six year obligation.

Active Duty for Training Assignments will be closely related to civilian occupation:

1. Navy schools of your choice, as eligible
2. Military Sealift Command Headquarters/Staff
3. Naval Control of Shipping Organizations
4. Naval shipyards as eligible
5. Navy ship (if requested)—may specify ship type, homeport, and billet
6. Military Sealift Command ships (as available)

NOTE: Navy correspondence courses are available anytime upon request.

Promotion opportunities:

to LTJG—automatic
above LTJG—compete only with other Merchant Marine Reserve (16X5) officers (chances excellent)

Retirement: Eligible for military retirement, including all benefits after completion of a minimum of 20 years of qualifying service.

Figure 1-2.—Summary of the Merchant Marine Reserve, U.S. Naval Reserve Programs.

CHAPTER 2

SEA POWER

Sea power as a concept means more than military power at sea. According to one definition:

> Sea power is the sum of a nation's capabilities to implement its interest in the ocean, by using the ocean areas for political, economic, and military activities in peace or war in order to attain national objectives with principal components of sea power being naval power, ocean science, ocean industry, ocean commerce, and ship construction and repair capabilities.

HISTORY OF SEA POWER

There is evidence that sea power was an important influence in history as far back as 4000 years ago. The ancient Cretans, who are credited with being the first possessors of a navy and a merchant marine, were at that time dominating the peoples who lived on the shores of the Aegean sea—now Greece and Turkey. The Phoenicians were next to prosper from their mastery of the sea, and they are often referred to as the real pioneers in the use of maritime power. Their sea rule was long, but for various reasons eventually ended.

Then came the Greeks. Greece, a land of peninsulas, was marked for conquest by Persia in 492 B.C. The Greeks managed to repel the invaders twice in ensuing years, but the Persians reigned supreme on the sea. Then, according to legend, the Greek gods told the Athenians to put their trust in wooden walls, which the Greek commander Themistocles interpreted to mean ships.

In the decisive battle of Salamis in 480 B.C., the Persians moved to bottle up the Greek fleet, thus falling into the trap set by Themistocles. To engage the Greeks, Persian ships had to transit a narrow opening between the Greek mainland and the island of Salamis. This maneuver forced the Persians to fight with just a few ships at a time, more or less on even terms in spite of their superior numbers. For the first time in naval warfare, these tactics presented the chance for one fleet to flank the advance of another. And this the Greeks did, closing and ramming time and again. Badly outmaneuvered, Persian's "King of Kings" Xerxes witnessed the loss of half his ships, and thus the end of his hopes to conquer Greece. The ensuing period of peace, prosperity, and productivity in the arts (known as the Golden Age of Athens) lasted—significantly enough—just about as long as the Greek city-states maintained their collective sea power.

Rome, which succeeded to greatness first by alliance with the powerful Greek city-states and more enduringly by absorption of Greek culture, found a formidable rival. This was Carthage, which had been a Phoenician colony.

At the outset of the Punic wars, Rome, recognizing the need for sea power, greatly enlarged her modest navy. At this early age the Romans were not particularly able sailors nor were they adept tacticians. With ships superior in size and numbers plus some clever innovations however, they eventually were able to sweep the more skillful Carthaginians in their lighter vessels from the sea. Roman seamanship improved rapidly, and it was Rome's sea power that forced Hannibal to take the difficult overland route to Italy via Spain and the Alps, thereby losing about half his forces. It was Roman sea power also that enabled her to move her powerful legions over the Mediterranean almost at will building an empire which endured for almost 600 years.

Following the fall of Rome, Constantinople on the Bosporus—watergate between Europe and the Near East—became the center of ancient culture. Renaissance Venice succeeded Constantinople as a great sea power of its era, but much of the Mediterranean was now a Moorish lake. This put a halt to European commerce with Asia and Africa, except at the extravagant risk of

paying tribute to one pirate ruler after another—a custom that was to prevail until American sea power helped abolish it more than 350 years later.

The age of exploration and colonization was the age of sea power in its broadest applications. The nations employing it became rich and powerful. These nations profited by what ships brought them, and the world profited by what they sent forth in ships. Inevitably there were collisions between the maritime rivals, and many wars were fought between opposing sea powers. When sea power meets sea power, what factors determine who shall be the victor?

All other things being equal, victory is assured the contestant who has the soundest knowledge of the sea and use of ships on the sea. It was know-how—the combination of technical knowledge and practical skill—that made Drake the master of the Duke of Medina-Sidonia and set Nelson above Villeneuve.

Three great maritime powers—Spain, Portugal, and France—each made great and enduring contributions to discovery, exploration, and colonization overseas, but their power finally dwindled either because they did not fully understand the use of the sea, or because their comprehension was inferior to that of their opponents.

Portugal's gaudy but brief career as a sea power was extinguished by her stronger rival and enveloping neighbor, Spain.

Spain gained through sea power an empire that has since been divided into half-a-hundred sovereignties, but the Spanish language and Spanish customs still persist from the Philippine Republic to Mexico and Patagonia.

Probably no investment in history yielded greater dividends than the $5000 or so with which Queen Isabella financed the voyage of Columbus into the western sea. Before long, the steady stream of silver and gold from distant shores was pouring millions a year into the royal coffers. Treasure-laden ships sailed not singly but in groups shepherded by warships. This was an early example of a protective convoy.

From 1492 to 1588 Spain stood in the forefront of the nations of Europe. But Spain was a classic example of sea power expressed in terms of quantity rather than of quality.

In 1588 her king, Philip II, determined finally to end the successful English raids on Spanish ships and ports and to bring England back into the Catholic fold by attacking her with what seemed an irresistible military force. A fleet of 124 ships, manned by 8.000 sailors and carrying 19,000 soldiers, made up the Spanish Grand Invincible Armada when it entered the English Channel. To oppose it, the English had only 90 ships, plus a mosquito fleet which had never seen action. However, they also had the know-how personified in Sir Francis Drake and his men.

The Armada was organized along the same lines as an army; it was under the command of a general, the Duke of Medina-Sidonia, who knew little of naval warfare. On the other hand, Drake, a master mariner, knew how to use wind and tide as allies. The confrontation that ensued marked the turning point in naval tactics. Previously, naval battles had been virtually infantry fights on floating platforms. If ramming did not sink an enemy ship, soldiers were sent swarming over her side to engage in hand-to-hand conflict. The English, however, planned something quite different on this occasion. They maneuvered to windward of the Spaniards and pounded them with artillery from a distance. This deprived the soldiers of the opportunity to come to grips with the enemy. The big lumbering Spanish ships, with their towering upper works, were splendid targets.

The Spanish, ignoring a chance to attack the English off Plymouth, sailed on up the Channel. The English pecked away at the Armada on its trip up the Channel, but did little damage except to induce the Spaniards to fire all their heavy shot with no telling effects. The Spaniards anchored in Calais, and during the night the English forced them out by floating several burning hulks down on them. The combined English and Dutch fleets attacked the Armada the next day and might have crushed it if they had had ample powder and shot. As it was, the demoralized Spaniards fled north and rounded the British Isles to the Atlantic where storms nearly succeeded in finishing what the English had started. The defeat of the Armada ushered in the decline of Spain's world dominance, while England went on to become mistress of the sea.

While not achieving any great destruction of the enemy, the English demonstrated superior adaptability of tactics to weapons. From that time on, gunnery gradually replaced shock action in battles at sea. The cries of "Boarders away!" and "Stand by to repel boarders!" gradually became less frequent. The day was still far distant when ships would become targets while still hull down on the horizon, but that was the direction of naval progress after the decisive Armada defeat.

The French did not have the compulsion to take to the sea as did the British and Dutch. Their national policy was to develop their rich land and defend it against predatory neighbors while expending minimum resources toward extending the nation's sea power. French naval captains were ordered to avoid risk—a policy not designed to control the seas by destruction of enemy naval forces, but merely to dispute them by commerce raiding. In the end, this policy cost France both her navy and her merchant fleets, and contributed to the loss of Canada and other overseas colonies.

The American Revolution had elements of a maritime war, and it was sea power that eventually helped to win independence for the colonies.

The final and decisive battle at Yorktown would never have occurred had not the French fleet under de Grasse attained command of the sea in the Virginia Capes area. Thus Cornwallis, the British commander, surrounded on the landward side by the combined Franco-American army and on the seaward side by the French fleet, was forced to surrender.

General George Washington understood sea power and appreciated its use as indicated in his statements below:

> In any operation, and under all circumstances, a decisive naval superiority is to be considered as a fundamental principle, and the basis upon which every hope of success must ultimately depend.

Again, he said:

> Whatever efforts are made by land armies, the navy must have the casting vote in the present conflict. . . .A constant naval superiority would terminate the war speedily; without it, I do not know that it will ever be terminated honorably.

Later, as President, Washington pointed out that U.S. commerce required a naval force to protect it and then added something the American people promptly forgot: that the most sincere neutrality offered in itself little protection against the depredations of nations at war. Only a navy organized and ready to vindicate it from insult or aggression could secure respect to a neutral flag. He added that such a force might even prevent the necessity of going to war at all.

Napoleon, although a master strategist on land, had little knowledge of war at sea. He looked in vain for a naval officer who really understood sea power. He said:

> The great weakness of our navy is that the men who command it are inexperienced in all the hazards of command. I look increasingly for the right naval officer without being able to find him. In that profession there is a specialty, a technicality, which put a limit to all my conceptions.

Characteristic of the superior use of sea power by the British are the naval aspects of the Napoleonic Wars. It was the combined land forces of Britain and her allies that eventually crushed Napoleon's armies and broke his power. But sea power had been working steadily and relentlessly to contribute to that end. Sea power enabled first Sir John Moore and then the Duke of Wellington to conduct a war on the extended flanks of the French in Spain and Portugal, and then at the strategic moment to shift those same troops to Flanders on the way to Waterloo. Nelson laid the foundations for this mobility in the great victories of the Nile, Cape St. Vincent, and Trafalgar which closed the sea to the French but made it an open highway for the British. British land forces were never more than fractional compared with Napoleon's Grand Army. But Napoleonic strategy demanded troops stationed everywhere in Europe, while the British needed to strike only in selected spots of their own choosing. Sea power enabled the British to apply concentrated power against Napoleon's weak point on his own territory.

It was during the Napoleonic Wars that American sea power first was used to implement the foreign policy of the recently created United States. The United States, along with other nations, had for some time been paying tribute to the so-called Barbary Powers to prevent the seizure of shipping by pirates of these countries. This practice was ended when it was finally decided that gunpowder instead of tribute was the best solution to the problem.

In the war of 1812, despite a few highly successful frigate duels, the few American saltwater warships and merchantships were eventually tightly blockaded by overwhelming British forces. It was American privateers or

commerce-raiding missions who achieved surprising success against England's merchant marine. Although they by no means inhibited the power of the British fleet or caused any lasting effect on the British economy, the British government, heavily engaged in European struggles, felt it best to negotiate a reasonable peace.

In the Civil War, control of the sea was overwhelmingly in the hands of the North. For 4 years the Union Navy was constantly occupied with the task of blockading more than 3000 miles of coastline, running down Southern commerce raiders, cooperating with the Army in capturing coastal strongholds, and opening the Mississippi and other waterways that led into the South. The South countered with commerce raiders, but the strangling effect of the Union blockade eventually took its toll. It crippled the finances of the Confederacy, shut out foodstuffs and munitions, and proved a major factor in deciding the outcome of the war. The country learned from this war that a navy could not be quickly and readily improvised in an emergency. Even then, the days were past when merchant vessels could be converted rapidly into efficient men-of-war.

When the Spanish-American War broke out, it was at once recognized that the conflict would be primarily naval and would be won by the nation that secured control of the sea. The Spanish Navy at that time was characterized by poor equipment, incompetence, and lack of trained personnel; while the U.S. Navy, though small, was soon prepared for aggressive actions at sea. Both at Manila Bay and Santiago the enemy's fleet was destroyed. Although Dewey's victory at Manila Bay had little material effect on the war, the destruction of Admiral Cervera's ships off Santiago, Cuba, established the U.S. Navy's command of the Caribbean.

MAHAN ON SEA POWER

The first use of the term "sea power" was by Captain Alfred Thayer Mahan (fig. 2-1), U.S. Navy, in his principal work. *The Influence of Sea Power Upon History*, 1660-1783, was published in 1890. In this work, and others, Mahan expounded a geopolitical theory which looked to control of the world's oceans as the source of national power.

The origin of his sea power theory was an historical analysis from which Mahan extracted "permanent facts" and "determinative features" from the past through study and judgement. From his analysis, he developed a theory and tried to prove it through selective application of historical facts and examples. Furthermore Mahan attempted to make scientific predictions of future events based on his Theory of Sea Power.

134.15

Figure 2-1.—A philosopher of naval strategy, Mahan's researches in military history prove that the nation controlling the oceans is the nation that maintains its supremacy in war or peace.

Mahan's philosophy of world politics upon which he based his theory, was composed of two distinct, yet related concepts. The first of these is that commercial and industrial might is the basis for national power. The great nation will be one that is able to expand its technological and commercial base relative to other countries. This emphasis on expansionism has resulted in the concept being termed Merchantilistic Imperialism.

Mahan observed that industrial and commercial power is developed when manufactured goods and other services are exchanged for a greater variety of raw material, which then can be used to produce more technology superior products. This in turn produces an excess of capital, which can be used

for the expansion of the commercial and industrial system. Since 75 percent of the earth's surface is water, and transportation by water is easier and cheaper than by land, the sea becomes the great highway of commerce over which the expanded foreign trade for raw materials must travel.

From Mahan's historical viewpoint, the expansion of shipping and trade leads to the establishment of overseas colonies either for trade or military purposes. Trade and colonization, however, do not take place in a vacuum, since other nations would be unwilling to allow one nation to grow at their expense. The result is competition among nations for the most desirable resources, which may escalate into armed conflicts. At this point, the need arises to create a navy (or sea force) to protect the ocean-borne link between the colonies and the mother country.

As a nation continues to expand its industrial and commercial base, it becomes necessary to strengthen the navy and develop more overseas bases to protect its empire and command the seas. As Mahan states, "Command of the sea is a prerequisite to a nation's greatness. This command of the sea would guarantee, in war and peace, the continuance of maritime commerce."

The second concept, which is a part of Mahan's theory, is that to maintain control of the seas, a nation must concentrate its forces to achieve "Battle Fleet Supremacy" so that the enemy's forces can be dispersed. These naval forces should be located at overseas bases that control the major trade routes. The ships themselves must have good endurance and stability for long ocean voyages as well as sufficient firepower.

If the theory that maritime power is a vitally important requirement for national power and greatness is true, why is it that all nations are not maritime powers? Mahan answered this question by isolating six elements that are determining factors in the development of sea power. These elements are a nation's (1) geographic position conducive to the use of sea power, (2) physical conformation, including natural productions and climate, (3) extent of territory, (4) size of population, (5) character of the people, and (6) character of the government, including its national institutions.

Geographical position was described as the most significant factor in the rise of English sea power to world dominance. England was ideally situated astride the major sealanes of European trade. Therefore, in time of peace she would prosper commercially and in time of war deny the use of these vital sealanes to her enemies. I addition, her insular position protected her fro ready invasion by enemies and obviated th necessity of a large army similar to thos maintained by nations on the continent.

Mahan observed, however, that an advan tageous geographical position is not the sol determining factor in the sea power comple Advantageous position avails a nation little if sh does not have a suitable physical conformatio i.e., an adequate coastline with numerous fi harbors. National abundance and climate a closely allied with the factor of physical confo mation. If a land with a salutary climate an natural abundance can satisfy her own wants, sh will seldom look seaward. England, lacking thes natural endowments, was compelled to turn to th sea.

Mahan's third and fourth conditions, exte of territory and size of population, are inte dependent. A nation must not only have a adequate seacoast with good harbors, but also h population must be large enough to defend h accessible shores. It must be remembered th seacoasts and harbors are not only outlets for nation's commerce but also a means of penetra tion by her enemies.

The gist of Mahan's fifth factor, nation character, is that any nation desirous of becomi a sea power must have an aptitude for commerci enterprise and a bent for the sea.

Finally, the character of the government of nation bidding for sea power prominence mu be considered. The type of government must b such as to exert a guiding influence on the existi national characteristics and channel these trai into a quest for maritime dominance.

In summary, Mahan's formula for sea pow called for developing domestic productio foreign trade, shipping interests, colonies, and navy. His philosophy of sea power strengthen the economic and political forces alrea stimulating naval development; this acceleratio in navalism fostered and supported the ne imperialism, which immediately called for st further naval construction. His elements of pow on the sea, navalism and imperialism we inextricably linked; each was in turn cause a effect in the endless chain of national growt national prosperity, and national destiny. The k word for Mahan was expansion. Commercial a industrial expansion produced national greatne and he believed that the Theory of Sea Pow explained better than any other theory w certain nations were able to industrially a

commercially expand despite the lack of available resources and manpower within their national boundaries.

MAHAN'S IMPACT

Mahan's geopolitical Theory of Sea Power was very closely studied especially by the naval officers of Great Britain, Germany, and Japan and influenced naval development in those countries. Another firm believer was Mahan's friend, President Theodore Roosevelt. Mahan's concept became the intellectual force behind the physical development of the U.S. Navy.

In 1907 President Roosevelt ordered the bulk of U.S. sea power to sail around the world. This composite of 16 battleships was designed to impress upon the world, and particularly upon the Japanese who were posing a growing threat in the Pacific, the fact that the U.S. Navy was second in strength only to that of Great Britain. By the time the Great White Fleet finished its 2-year cruise, the United States already had launched an even more impressive addition to her fleet, the USS *Delaware*, built to keep pace with HMS *Dread Nought* which was setting the pattern for a new era of naval warfare.

SEA POWER IN MODERN TIMES

Mahan's sea power doctrine had its basis in a world that no longer exists. The changes in the complexion of warfare arising from two world wars has caused reconsideration of the Capital Ship Theory and the basic theory of he who rules the sea, rules the world.

"Guerre du Course" (war against commerce) was dismissed by Mahan as being of secondary importance to destroying an enemy's fleet. During World War I, however, Germany concentrated on sinking merchant ships rather than the British capital fleet. She was able to do this because all needed raw materials and basic necessities were available via land routes. It was not vital to command the sea, only to deny its use to the British.

The result of Germany's unrestricted submarine warfare was a very successful blockade that nearly knocked Great Britain out of the war. The mining of the North Sea and the convoy system enabled the Allies to break the enemy stranglehold and maintain control of the seas. Nations that depend on the sea for essential imports learned that destruction of the opponent's capital fleet is not the only prerequisite for command of the sea. Merchant shipping must also be protected.

"Guerre du Course" in the Second World War was essentially the same as World War I, with the exception of some more refined techniques. The development of radar during the course of the conflict drastically altered the nature of submarine warfare and essentially drove the submarine underwater thus ending the submarine threat to merchant shipping.

The maturation of amphibious warfare and the aircraft carrier during World War II also had consequences for Mahan's seapower theory. Sea control is a necessary requirement for the successful projection of power ashore (as in an amphibious assault). Since Germany did not actively contest the Allied control of the Mediterranean and eastern Atlantic, an amphibious force could strike at any point along the coastline of German territory. Germany was forced to spread out her forces, ensuring that the amphibious campaigns of North Africa, Sicily, Italy, and Normandy would succeed.

In the Pacific, with local control of the sea, Japan was able to capture Singapore, the Western Aleutians, the East Indies, the Solomons, and to threaten Australia. When she lost this control, she was unable to send men, supplies, and ships even to the aid of Okinawa, threshold of the homeland. In the first years of the war, the U.S. range of operation was limited. As the United States reduced Japan's Navy and as her own grew, especially with respect to naval air superiority, it became possible to operate more freely, to bypass enemy strongholds, and to omit many grueling campaigns.

Because of the effects of sea power, U.S. landings in Leyte and Lingayen were ahead of schedule. Inability to move on the sea prevented the Japanese from exploiting their strength in the Philippines and from satisfactorily reinforcing their troops at the point of attack. Control of the sea made it possible for U.S. forces to bypass many islands and avoid waters controlled by the enemy.

Sea power permits multiple use of the same force; a small army becomes in effect many armies. With a handful of divisions, the Pacific Area forces drove steadily toward the Japanese home islands. In much of the central and western Pacific, the Japanese had a strong numerical superiority, but a large portion of her troops never got into combat. Without adequate shipping and naval air power, the Japanese legions were helpless; with a sufficient number of aircraft

carriers, the few U.S. divisions were superior to the many that opposed them. The aircraft carrier was essential to command of the seas, and command of the seas was essential to the projection of power inland and the ability to influence events on land.

When North Korea attacked south of the 38th parallel, the U.S. Navy was called upon for close air support to knock out bridges and block enemy supply routes. Jet aircraft flew from carriers for the first time in a war situation. Also in Korea the helicopter came of age. The helicopters were used as platforms for artillery spotters, emergency supply runs, search and rescue missions, and cargo transport between ships. The helo was used also for antisubmarine warfare exercises.

The United States' sea power role during the Viet Nam conflict was varied. From gunfire support and aircraft carrier operations off shore to coastal interdiction and riverine operations by swarms of various types of patrol craft, the role was ever changing. Naval construction battlions (Seabees) built airfields ashore. Over 90 percent of the personnel and supplies were transported to Vietnam by sea.

THE EVOLUTION OF SEA POWER

In the period since 1945, there have been further economic, political, and technological changes to the world Mahan knew. A reappraisal of Mahan's philosophy in the light of today's naval responsibilities and capabilities, has shown flaws inherent in his original concept. Mahan did not envision the relative decline of English sea power and the corresponding rise of three competing industrialized sea powers—the United States, Japan, and Germany. Also, he advocated an arrangement whereby a mother country was enriched and supported by her colonies. This concept has been largely supplanted in the West by capitalistic industrialization and trade. A concomitant feature of industry allied with science has been the introduction of refined and diverse methods of warfare. The submarine, the supersonic aircraft, and the guided missile were unknown in Mahan's age; and their introduction has necessitated changes in the present connotation of the term "sea power." Finally Mahan viewed the struggle for sea power supremacy as centered in the Atlantic Ocean and looked upon the Pacific Ocean as an area of only subsidiary importance. A look at World War II shows that this is not so.

These apparent flaws in Mahan's doctrin raise the question whether a sea power concep is still tenable and applicable to modern navies A close analysis will show the growing importanc of sea power today and tomorrow.

No nation has ever been economically self sufficient. As in the past, nations in the futur will need the natural resources and manufacture goods of other nations.

To get these commodities, you must have means of transportation to carry the resources an goods to a nation's homeland. Water transpor tation is presently the most economical an practicable means of transporting this great bul of material between nations. In peace or war more than 99 percent of all international trad moves on the sea.

Use of the sea as a means of transport implie a control of the sea when that use is opposed b other nations. Thus, the initial and primar mission of a nation's navy is to gain control o the sea for that nation and, if necessary, to den the use of the sea to others. The importance o controlling the sea and denying its use to enemie is as great today as it was in the past. The nev inland reach of sea power has had a far-reachin effect on all military strategy. With the advent o missiles from beneath the ocean, supersonic jet carrying nuclear warheads, and the ability t project combat-ready marines far inland, th strategies put forth by Mahan must be drasticall revised to include the naval forces in an consideration of land hostilities—in offense o defense.

MISSION OF THE NAVY

We have established that sea force was a vita element of sea power. Mahan envisioned this a a force primarily to protect merchant ships at se and also as a force to project power to far-of overseas bases in order to establish a worldwid maritime communications system. The Navy o sea force then was not just a defensive force bu also a vital arm of national policy for a maritim nation; a method for helping to fulfill nationa objectives.

A legacy of Mahan's theory is found toda in the mission of the U.S. Navy as established b Title 10 of the U.S. Code. The Navy is to b prepared to conduct prompt and sustaine combat at sea in support of the United State national interests. This mission can be bette understood if it is subdivided into four distinc

mission areas which represent the tasks actually performed by the people, ships, and aircraft that comprise our Navy. These mission areas are strategic nuclear deterrence, naval presence, sea control, and projection of national power.

PEACETIME MISSION AREAS

The primary reason any nation maintains a military force in peacetime is to deter the outbreak of armed conflict in which it would be involved. The first two mission areas, strategic nuclear deterrence and naval presence, represent the peacetime tasks of the Navy.

Strategic Nuclear Deterrence

The goal of strategic nuclear deterrence is to prevent the use of nuclear weapons against the United States or its allies. The 41 ballistic missile submarines of the Navy, represent only one portion of the TRIAD of nuclear forces which comprise the nation's nuclear deterrent. The other elements of the TRIAD are intercontinental ballistic missiles (ICBM's), and land-based bombers.

The purpose of such a diversified deterrent is to guarantee that an Assured Second Strike capability is maintained. In other words, to prevent a nuclear attack, you should provide for a sufficient nuclear force that can withstand a surprise attack and yet still be able to retaliate and impose unacceptable damage on the attacker. The knowledge that they face near total destruction should deter any rational nation from attacking the United States with nuclear weapons. The TRIAD was created to ensure a second strike capability.

Naval Presence

No weapon systems have been created solely for the naval presence mission area. Instead, forces optimized to attain victory in wartime, are used in peacetime to reduce the likelihood of their ever being used. The naval presence objective, therefore, of U.S. naval units is to deter conventional armed conflict, not only for its own sake, but also to minimize the risk of localized political instabilities escalating into a nuclear war.

This is a very difficult area to assess, because naval presence activities are conducted to influence the actions of other countries. The extent of this influence depends upon the perceptions of those countries. When a policy decision of another government is visibly implemented, it is virtually impossible to determine what part naval presence activities played in that decision.

WARTIME MISSION AREAS

Should the efforts of the United States fail to prevent war, the Navy has two basic functions it must be able to perform in a hostile environment, sea control and power projection. The ability to perform both of these mission areas is a requirement if the United States is to use the seas to support its national policies and to defeat the forces of any state that would seek to deny such use. The functions of sea control and power projection are closely interrelated. Some degree of sea control is necessary in the sea area from which power is to be projected, depending on the type force to be employed. Conversely, the capability to project power was developed in naval forces largely as one means of achieving or supporting sea control.

Sea Control

Sea control is the capability to *selectively* use those *portions* of the high seas essential to the national interests. Note the emphasis in this mission area. This is not the same concept as Mahan's command of the seas. The development of long ranged land-based aircraft, sea-based aircraft, and nuclear powered submarines has changed control of the seas into a three-dimensional problem. Given this new technology, it is virtually impossible to totally control the seas for our own use or to totally deny them to the enemy. "Sea control" is a selective function exercised only when and where needed. It is required so that the U.S. Navy may have operating areas that are secure for the projection of power, such as carrier strike or amphibious assault, and sea lines of communication that assure buildup and resupply of allied forces in the theater of operations and free flow of strategic resources. Effective sea control also enhances security for the nation's sea-based strategic deterrent.

Sea control is a prerequisite to the conduct of sustained overseas operations by U.S. Army and U.S. Air Force general purpose forces. Modern land warfare generates logistic requirements of such proportions that the overwhelming amount of material needed must be supplied by sea.

Sea control is achieved by the destruction or neutralization of hostile aircraft, surface ships, and submarines which, by their presence threaten U.S. or friendly forces operating in those maritime areas which the United States must use.

For analytical purposes, sea control may be categorized as area or local. Area sea control includes extended operations to engage and destroy hostile forces, such as seizure or neutralization of enemy bases or key areas, and denial to the enemy of access routes to the sea. Local sea control includes close defense of U.S. and allied naval and merchant units and of friendly forces engaged in other operations, such as amphibious assault and mine warfare. Sea control can be achieved or supported in several ways including:

1. Operations which are designed to locate and destroy hostile naval combat units on the high seas

2. Barrier or blockade operations designed to deny enemy naval forces access to open oceans or specific areas, taking advantage, where possible, of geographic choke points

3. The use of moving barriers to clear the sea area surrounding ships in transit, such as military or commercial convoys and amphibious or support forces

4. The use of mines in such areas as harbor entrances and choke points

The use of carrier forces and Marine amphibious forces in the projection of military power can be an absolute necessity to ensure control and continued safe use of the high seas and contiguous land areas essential to control of the seas. This entails destruction of enemy naval forces at their home bases or en route to those ocean areas which the United States desires to protect, destroying their logistic support, or preventing the approach of enemy forces within range from which their weapons can be employed against U.S. forces.

Power Projection

As an independent mission area, power projection is a means of supporting land or air campaigns using capabilities designed for naval tasks. Power projection covers a broad spectrum of offensive naval operations including strategic nuclear response by fleet ballistic missile forces, employment of carrier-based aircraft, amphibious assault forces, and naval bombardment with guns and missiles of enemy targets ashore in support of air or land campaigns.

An essential element of power projection is the Navy amphibious ship with Marines embarked, the nation's only major means of inserting U.S. ground forces into the hostile environment of an opposed landing operation. Carrier aircraft, in the power projection function, are able to strike land targets with a variety of weapons, conventional or nuclear. The ultimate means of power projection is through the ballistic missile submarine force. Each element of power projection requires a measure of sea control for its effective execution, and that function can be exercised simultaneously with the projection function, if necessary.

ARMS CONTROL

The probability of a strategic nuclear attack on the United States is very low. The consequences of such an attack, however, would be catastrophic; so the TRIAD, a powerful strategic force, has been developed and maintained to deter it. Similarly, the Soviet Union has developed and is maintaining powerful strategic forces of its own. Our objective is to obtain a condition of essential equivalence-a condition in which:

1. Soviet strategic nuclear forces do not become effective instruments of political leverage or coercion.

2. Nuclear stability is maintained.

3. Advantages in force characteristics enjoyed by the Soviets are offset by U.S. advantages in other characteristics.

4. U.S. strategic forces are not in fact, and are not perceived to be, inferior in performance to those of the Soviet Union. It is imperative that our TRIAD be perceived by potential opponents and allies to be credible. If their perception

is that it is not, regardless of the facts, it will no longer serve to deter an attack.

This condition of essential equivalence should produce a mutual deterrence that is so stable that it will not be upset in a crisis and so that neither side will be able unilaterally to upset it over the long term. These short and long stability objectives of the United States are sought through a combination of specific, equitable, and verifiable arms control agreements and through unilateral force modernization as required.

The focus on relations between the United States and the Soviet Union is necessary because they are the greatest military powers in the world today. For the foreseeable future, as the President has said, the two countries will continue to cooperate and to compete. The precise mixture of the two will depend on the place, the issue, and how each sees its own national interests in a particular case.

The Soviets appear willing to strike some bargains, as in the Strategic Arms Limitation talks (SALT), that can reduce the chances of mutual destruction. At the same time, because their interests and objectives diverge in important respects, there have been and will be times and places where U.S. and Soviet policies will conflict and tensions will arise. A history of arms control agreements exists between the two superpowers stretching back to 1959.

The first round of SALT, concluded in 1972, produced the Antiballistic Missile (ABM) Treaty which severely restricts the deployment of ABM systems by either country. Since then there have been many talks on Strategic Arms Limitations and Reductions but no new treaties have been ratified.

SOVIET MARITIME POWER

The degree to which we maintain adequate nuclear and nonnuclear forces will determine what the Soviet threats to our interests are likely to be. One area that has received much attention in recent years is the enormous growth of Soviet maritime power. Its Navy, merchant marine, fishing, and research fleet, as well as supporting industries, have grown very rapidly in the past two decades. An examination of each of these elements of Soviet maritime power may point out nonnuclear areas of competition which have the potential to menace our national interests.

THE SOVIET NAVY

Soviet military strategy has expanded beyond one of just continental defense. Today most Soviet military front line organizations are more offensively oriented. In some cases, such as the strategic rocket forces, the Navy, and foreign military assistance, the Soviets have developed capabilities which have global implications. The most dramatic development since the early 1960's in overall Soviet strategy has been the evolution of its Navy.

The mission and task orientation of the Soviet Navy differed significantly in the past from that of the U.S. Navy. When the capabilities of the Soviet Navy were emergent, the principal concern of the Soviet naval leadership was the defense of the sea approaches to the Soviet state and a measure of sea denial-interference with the free use of the seas for the transport of raw materials, reinforcements, and resupply cargos by its adversaries. With the attainment of a powerful navy, Soviet naval leaders now speak of the mission and roles of their navy in terms which, in some cases apply equally to the U.S. Navy. The basic continuing difference in strategies of the two navies is dependent on geopolitical considerations. The United States will continue to need the free use of the seas for its raw materials, commerce, and wartime support of its allies, while the Soviet Union will continue to recognize the importance of denying that use.

The strategic role of the Soviet maritime forces can be clearly deduced from the geopolitical situation of the USSR. Militarily, the Soviet Union is the most powerful state on the Eurasian continent with large reserves of natural resources and a broad, expanding technology base. Its principal allies, the Warsaw Pact nations, are contiguous to its western border. Its major potential adversaries, the People's Republic of China on its southeast flank and NATO Europe to the west, are on the same land mass. As a result, the Soviet Union can rely almost entirely on internal lines of communication. These conditions have produced a Soviet Navy with the primary roles of:

1. Strategic nuclear strike and deterrence. Today the Soviet Navy routinely deploys submarines

hit most U.S. targets even if launched from Soviet coastal waters or home ports. The Soviets have the largest force of ballistic missile submarines in the world and based on the numbers being built, it seems that they intend to place increasing reliance on them as a major portion of their total strategic striking power.

2. Destruction of enemy naval forces. The Soviet concept of destroying enemy naval forces embraces the naval warfighting tasks of defense against strike forces, nuclear ballistic missile submarine (SSBN) support, and countering sea control/projection forces. The destruction of SSBNs and aircraft carriers is a priority concern of the Soviet Navy, and the Soviets continue to seek improvements in antisubmarine warfare. Soviet naval exercises and writings indicate the evolution of the role of protecting their own SSBNs from enemy ASW forces. The Soviets continue to rely upon the concept of defense in depth against enemy naval projection forces, using long-range aircraft and submarines to attack approaching enemy forces at some distance from Soviet territory. They also maintain the world's largest force of missile-armed surface combatants and mine warfare craft.

3. Sea Lines of Communication (SLOC) interdiction. The Soviet Navy clearly possesses the necessary forces and capability to mount an intensive interdiction campaign against U.S. and allied SLOCs. The Soviets have the capability to begin SLOC interdiction in the early stages of a war. The intensity of the interdiction effort and the forces committed to it would depend upon the length and nature of the conflict.

4. Support of ground forces. The Soviet Navy retains the requirement to protect the ground forces' seaward flanks from attack by sea-based air, naval gunfire, and envelopment by enemy amphibious assault. In addition, the Soviet Navy has important offensive tasks in support of ground operations. These include gunfire support and the launching of amphibious operations by Soviet Naval Infantry against the enemy's flanks.

5. Support of state policy and interests. An evolving role for the Soviet Navy along the lines of the naval presence mission area of the U.S. Navy is support of foreign policy objectives. The Soviets have recognized the value of their Navy military might of their country. The senior Soviet naval officer, Fleet Admiral Sergei Gorshkov, put it in these words:

> Navies. . .are constantly being utilized as an instrument of state policy in peacetime. . .to employ and extend a military threat to any level, beginning with a show of military strength and ending with the disembarkation of a landing party.

6. Naval force projection ashore. This is an emerging mission. Although the Soviet Union has never conducted an amphibious assault operation in a distant area, Admiral Gorshkov's frequent mention of projection operations by Western navies displays a thorough knowledge and keen appreciation of the use of force projection. As Soviet global interests and perceived responsibilities expand, naval force projection may well be translated into a capability in distant areas. For example, in 1979 the Soviet Navy introduced a new class of amphibious ships that operates their new air cushion landing vehicles. The Soviets have already shown their willingness to use naval units as an interposition force, as in their operations off West Africa during the Angolan crisis in early 1976.

Soviet Navy Force Levels

The Soviet capacity to launch sea-based strategic nuclear attacks is provided by about 65 YANKEE and DELTA class and 30 other ballistic missile submarines. The strategic nuclear attack capability of the Soviet Navy was significantly enhanced by the introduction in 1968 of the YANKEE class SSBN, which carries 16 underwater-launched missiles, the latest versions of which have maximum ranges of 1600 nautical miles. The introduction in 1973 of the DELTA class SSBN, with its 12 missiles having a range of more than 4200 nautical miles made it possible for the Soviets to engage continental U.S. targets from Soviet waters. A larger version of the DELTA, the DELTA II, carries 16 of these missiles. The newest Soviet class, the TYPHOON, can carry 20 missiles and is approximately 25,000 DWT, making it the largest submarine in the world.

Current Soviet naval general purpose strength is displayed in Table 2-1.

Soviet Capabilities

The advent of the 37,000-ton KIEV-class aircraft carrier, the largest warship ever built in the Soviet Union, signaled the first genuine attempt by the Soviets to put fixed-wing aircraft to sea. The extent to which they develop their ability to employ sea-based airpower effectively, and the numbers of aircraft built, could have a great impact on the future role of the Soviet Navy. The KIEV-class guided missile antisubmarine warfare support aircraft carrier (CVSG) is best described as the first of a unique type of multi-purpose aircraft carrier, combining in a single hull a wide range of naval capabilities (figure 2-2). The Vertical/Short Take-Off and Landing (V/STOL) FORGER aircraft operates from the KIEV-class carrier. Although limited, this sea-based aviation capability is nonetheless the beginning of a new dimension to the Soviet Navy. It provides the embryo of what the Soviets have always lacked: the ability to provide air cover and air striking power as an indigenous part of the fleet when operating in distant waters. KIEV's mix of tactical jet V/STOL strike fighters and helicopters and her extensive weapons inventory (including potent, long-range, anti-ship cruise missiles; surface-to-air missiles; ASW ballistic rockets; torpedoes; and modern guns) give her capabilities which could be used in a variety of roles such as anti-ship strike, area air defense, ASW (both as platform for launching ASW attacks and as an ASW command ship), amphibious support, and sea control. The capabilities of KIEV far exceed those of the smaller ASW-oriented 17,000-ton MOSKVA-class guided missile helicopter ship.

All of the principal surface combatant classes introduced into the Soviet Navy since 1967 have an ASW capability. These units are large and heavily armed; in addition to their ASW capability, they have increased endurance, modern electronic systems, and improved air defense systems. Even though the Soviets say all their new large surface ships are designed for ASW, these

Table 2-1.—Naval Combatant Force Levels

Combatant Ship Category	US Active	In Construction	USSR Active	In Contruction
Aircraft Carrier	13	2	3	2
Battleships	2	-	0	-
Helicopter Cruisers	0	0	2	-
Cruisers	27	6	40	10
Destroyers	90	2	66	-
Frigates	80	29	192	2
Corvettes	-	-	26	-
Patrol Craft	-	-	18	-
Attack Craft	4	3	363	3
Submarines				
Attack (Torpedo)	85	22	213	13
Attack (Cruise Missile)	-	-	69	1
Ballistic	37	9	85	-
Amphibious	64	1	86	1
Mine Warfare	25	4	388	3
Replenishment	21	1	27	-
Support	59	-	28	-
Auxiliuries (Various)	89	-	439	-
Intelligence	-	8	57	1

ships have other significant capabilities, such as force air defense, anti-surface warfare, and support of Soviet foreign policy objectives.

The Soviets have the largest submarine force in the world and continue to improve its capabilities. Since the 1960s, submarines armed with torpedoes and cruise missiles have presented the most serious anti-ship threat to all naval surface forces and with the other Soviet attack submarines, could present an extremely serious threat to western SLOCs in a protracted conflict. Much of the Soviet effort in recent years has been to produce submarines with better ASW capabilities in order to complement other ASW forces, both to counter the Western SSBN threat and to help ensure the survivability of their own strategic strike forces.

Significant among the smaller combatant craft are the OSA missile attack boats which carry four anti-ship cruise missiles with an estimated 25-nautical mile range. Although the Soviet patrol combatants do not pose a severe open ocean threat against U.S. naval forces, they could be highly effective in restricted waters against the naval forces of the United States and its allies. In addition, they free the principal surface combatants for operations on the high seas.

The Soviets continue to place much emphasis on mine warfare. They have the world's largest stockpile of mines and maintain the largest, most diversified mine warfare force of any navy. The Soviet Navy is capable of laying mines from aircraft, submarines, and surface combatants. The Soviets are very active in mine development and have pioneered several new types of mines which can be activated or detonated by various means.

Soviet naval aviation (SNA) is comprised of over 1,300 fixed-wing aircraft and helicopters. Soviet naval aviation has taken two significant steps in the last several years: the introduction of a sea-based, fixed-wing capability on the aircraft carrier KIEV, and the introduction of the

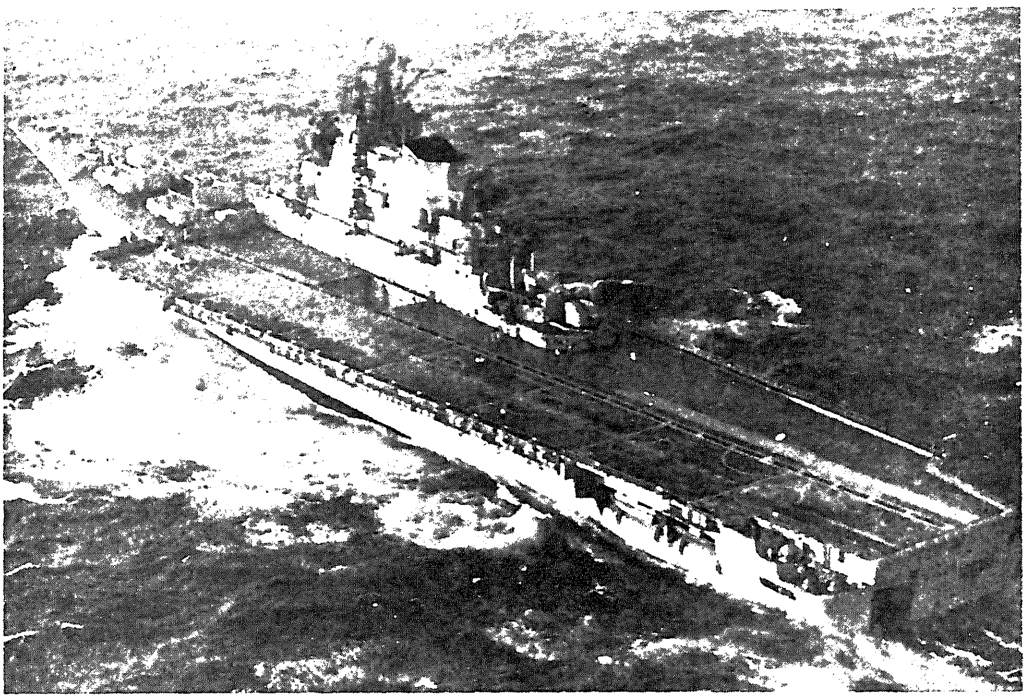

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Figure 2-2.—The aircraft carrier Kiev—called an antisubmarine cruiser by the Soviets—adds a new dimension to Soviet naval capabilities. The "flattop," displacing just over 37,000 tons, has the potential for antisubmarine, fleet air defense, reconnaissance, and antiship strike and close air support operations. Note the gun, missile, and rocket armament on her bow.

swing-wing, supersonic, missile-armed BACKFIRE bomber (figure 2-3).

FUTURE NAVAL CAPABILITIES

Although the size of the Soviet Navy will probably decrease somewhat during the next five to ten years, the overall capability of the forces will increase substantially. The Soviets are replacing older ships, submarines, and aircraft with new ones which possess much greater capability than their predecessors. (See fig. 2-4.) Construction of DELTA-Class SSBNs is expected to continue. They presently have two new submarine-launched ballistic missiles (SLBMs) in the advanced stages of development. Both are estimated to be MIRV-capable. The major changes in surface ship construction is in the area of air-capable ships. In addition to the two MOSKVA-class helicopter cruisers, the Soviets now have three KIEV-class carriers operational. Increases are also expected in the number of missile cruisers and surface-to-air missile destroyers. The projected air threat will increase, despite a projected slight decrease in numbers of aircraft, because of the introduction of the BACKFIRE. A more capable V/STOL aircraft is also foreseen. Continuing improvements in satellite surveillance and targeting can be expected.

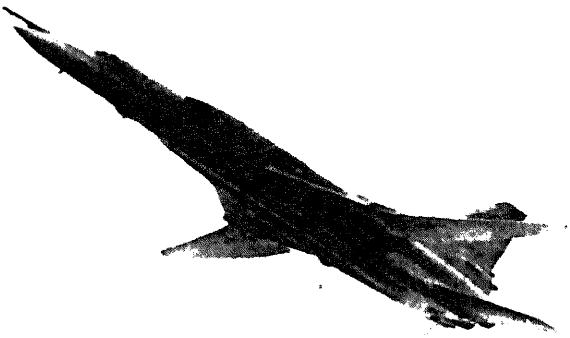

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Figure 2-3.—The swing-wing, supersonic, missile-armed BACKFIRE bomber.

The extensive and intensive use of the sea by the Soviet Union over the last two decades has not been limited to naval operations. In the best traditions of Mahan, the Soviets have embraced the whole spectrum of activities which are considered part of the sea power "equation"—merchant marine, fishing, oceanographic research, shipbuilding, a large pool of experienced seamen, and a knowledgeable leadership.

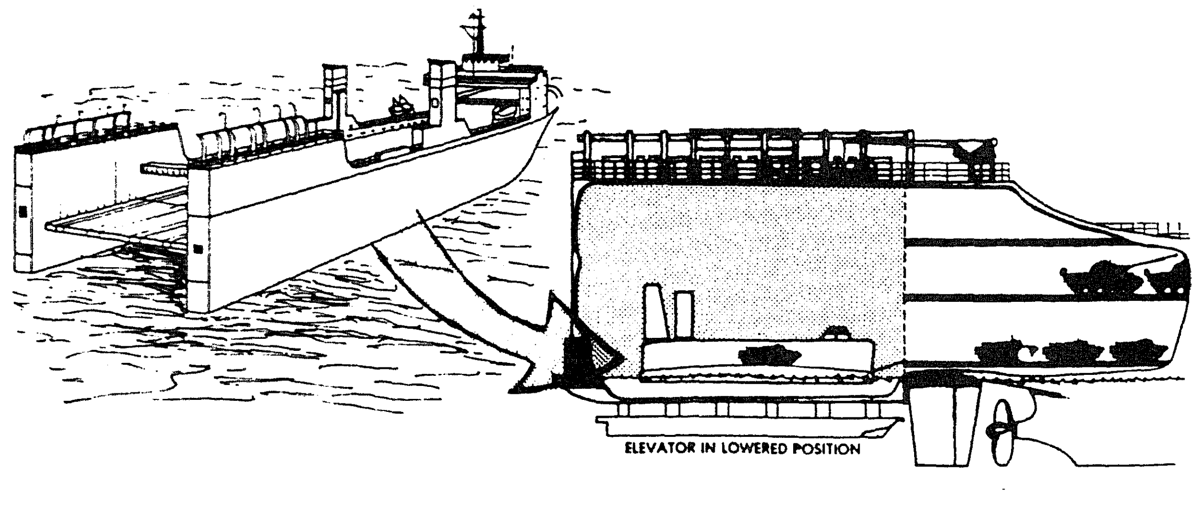

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Figure 2-4.—The shape of ships to come: Now under construction for the Soviet Union are large SEABEE barge-carrying ships. These ships, almost 900 feet long, displace over 50,000 tons, and carry loaded barges that can be unloaded by by a stern elevator. The lower drawings shows how the ships could unload tanks and air cushion vehicle landing craft. Soviet merchant ships have carried tanks and other military vehicles to the Middle East, countries in Africa and Asia, and to Cuba.

The Soviet concept of sea power encompasses intensive and coordinated use of all aspects of its natural, scientific, industrial, merchant, and naval resources in support of state policy. All the various elements of Soviet maritime activity have been developed by the deliberate and priority allocation of resources.

MERCHANT MARINE

The application of the Soviet basic philosophy of sea power is clearly demonstrated in the ongoing development of the merchant marine. At the end of World War II the Soviet merchant fleet consisted of about 400 ships totaling approximately two million deadweight tons. The ships were relatively small, old, and slow. In fact, the newest and best vessels were the lend-lease "Liberty" ships that the United States had provided the Soviets during the war.

In just three decades, the Soviet merchant fleet has emerged from that insignificant, coastal oriented fleet to rank second in the world in numbers of ships, and eighth in terms c deadweight (carrying) tonnage. The expansio continues. Today the Soviet Union has an ocea going cargo carrying fleet of nearly 2500 ship aggregating over 20 million deadweight tons. B comparison, the U.S. merchant marine, with jus under 600 ships equalling about 17 millio deadweight tons, ranks about tenth in bot number of ships and carrying capacity in worl ranking (table 2-2).

The Soviet merchant fleet is presentl operating on over 60 different trade lines calling at over 120 countries throughout the worlc Soviet merchant ships are now calling at some 7 different ports along the U.S. east, west and gul coasts as well as the Great Lakes. In 1975, th number of voyages made to the United States b Soviet merchant ships increased 56 percent ove 1974.

The growth of the Soviet merchant marine ha paralleled a period of equally dramatic worldwid maritime development, but the Soviet ac complishments have been unique. While th

Table 2-2.—Major Merchant Fleets of the World

Country	No. Ships[1]	Rank by No. of Ships[2]	Deadweight Tons	Rank (DWT)
Liberia	2,220	4	146,124,000	1
Greece	2,893	1	74,629,000	2
Japan	1,770	5	63,192,000	3
Panama	2,725	2	45,820,000	4
Norway	600	9	38,809,000	5
United Kingdom	927	6	37,146,000	6
U.S.S.R.	2,449	3	21,886,000	7
France	317	19	18,516,000	8
United States (Privately Owned)	448	11	17,447,000	9
Italy	606	8	16,551,000	10
Spain	510	12	12,525,000	11
Singapore	592	10	11,932,000	12
China (People's Republic of)	750	7	10,945,000	13
Germany (Federal Republic of)	440	15	10,790,000	14
India	378	16	9,464,000	15
All Others[3]	7,359		125,945,000	
Total	25,110		665,753,000	

[1] Oceangoing mechant ships of 1,000 gross tons and over.
[2] Includes 266 United States Government-Owned ships of 2,440,000 dwt.
[3] By number of ships, Korea (Republic of) ranked 13th with 449 vessels aggregating 8,040,000 dwt., and Netherlands ranked 14th with 445 vessels aggregating 7,768,000 dwt.

international growth has been spurred by the demand for big oil tankers, bulk carriers, and container ships, the Soviet Union has carefully directed the growth of its merchant fleet, not allowing purely commercial pressures of modern trade to dictate its composition. (See fig. 2-5.) It is of interest to note that while most nations have reduced their passenger carrying fleets, the Soviets continue to expand theirs and today have a greater number of passenger ships (fig. 2-6) than the rest of the world combined.

As a result, the Soviets today possess one of the few major merchant fleets that can perform either a peacetime commercial mission or satisfy military logistics requirements effectively and efficiently. This has been achieved by accepting some economic disadvantages in exchange for functional versatility. Rather than building only supertankers, container ships, liquid gas tankers, and bulk carriers, the Soviets have continued to improve the designs of their large, sophisticated cargo ships and small, multipurpose tankers. They also have stressed high-speed, Roll-On/Roll-Off (RO/RO) combination vehicle and container ships. The RO/RO ships offer the Soviets considerable versatility.

The RO/RO ship is basically a floating garage that loads and unloads cargo via a large ramp. It can easily transport most forms of military hardware without ship modification and without the necessity of sophisticated port facilities. The Soviet Union has more than 20 RO/RO ships operational and numerous additional ships scheduled to be delivered in the near future. These ships can operate on the most competitive commercial routes, yet they can be reallocated with very little delay to serve as a military sealift or logistics ships.

The Soviets have ordered two large, U.S. designed SEABEE barge transport ships from Finland. The SEABEE represents another advanced concept in cargo handling; it can transport large unit loads, such as 1,000-ton barges, and has potential use in logistics or even amphibious lift operations. Cargo is loaded with a stern-mounted, 2,000-ton-capacity elevator. Up to 25,000 tons of cargo can be off-loaded in only 13 hours. A SEABEE ship, acting as a landing craft mother ship, could contribute significantly to Soviet amphibious capabilities.

The Soviet 1976-1980 five-year plan calls for a growth in foreign trade of 30 to 35 percent, with particular emphasis on the capitalist world. In addition, the Soviet Union probably intends to use more of its merchant fleet to carry its own trade. Available figures indicate that the Soviet merchant marine already is carrying approximately 60 percent of the nation's imports (in comparison, the U.S. merchant marine carries about five percent of all U.S. imports).

The current five-year plan also projects a net gain of 3.4 million deadweight tons by 1980. If the stated goal is reached, the Soviet merchant marine will consist of approximately 2,000 ships totaling nearly 18.7 million deadweight tons by 1980.

The Soviet merchant marine has proved to be an effective tool for the extension of Soviet influence, as well as for neutralizing or eliminating Free World influence in strategic areas. Past activities of the merchant fleet in support of Soviet state policy, especially in African, middle Eastern and Indian Ocean waters, are contributing to a growing political acceptance of the Soviet presence in these areas.

The merchant marine, on a regular basis, provides a significant amount of the logistics support required by the Soviet Navy, particularly to those ships operating in waters distant from the U.S.S.R. This gives the Soviet Navy a high degree of flexibility. Additionally, these merchant ships have a much greater freedom of access to the ports of the world than navy ships or auxiliaries and thus can purchase fresh water, produce, and other supplies for naval use from ports where regular naval ship visits might be denied.

Today, Soviet merchant ships operate on all oceans, calling at ports throughout the globe. If a Soviet ship is in distress in distant waters, it usually is only a matter of hours before other Soviet ships arrive on the scene to assist.

In summary, the Soviet leadership no doubt sees the merchant marine providing the following advantages and capabilities:

- A large national resource providing valuable income, services, and employment
- An instrument to provide support for the foreign policy of the state and to further the cause of Soviet Communism
- A source of much needed foreign currency in the continuing "balance of payments" battle
- A visible sign to the world of the prestige and power of the Soviet Union
- A training system for an expanding pool of trained seamen

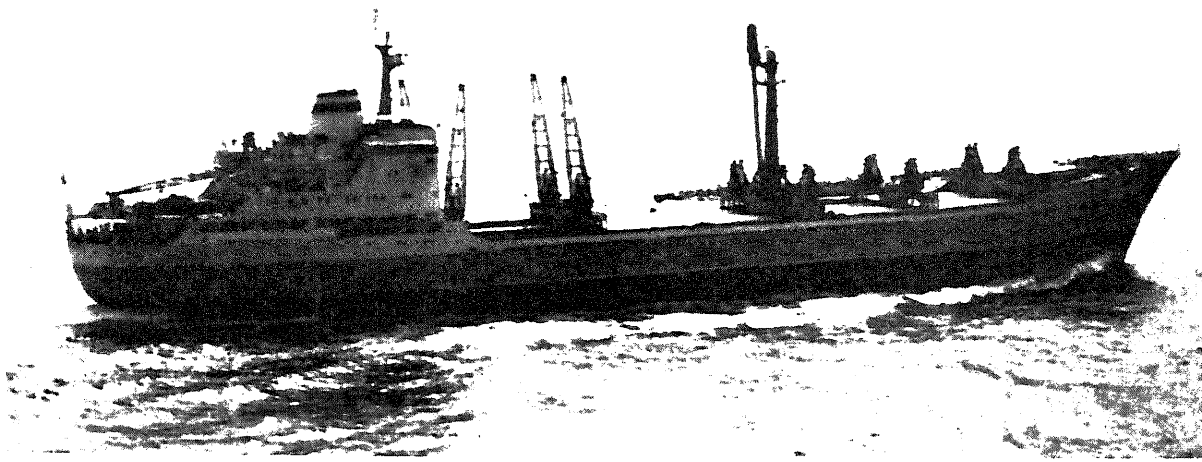

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Figure 2-5.—The Soviet freighter Prinneprovsk steams through the South China Sea after a run to Vietnam. This ship homeported at Odessa on the Black sea, is one of the Soviet Union's large fleet of relatively modern merchant ships Although most Soviet merchant ships are "break bulk" ships such as the Prinneprovsk, many modern container and bulk ships fly the hammer-and-sickle flag.

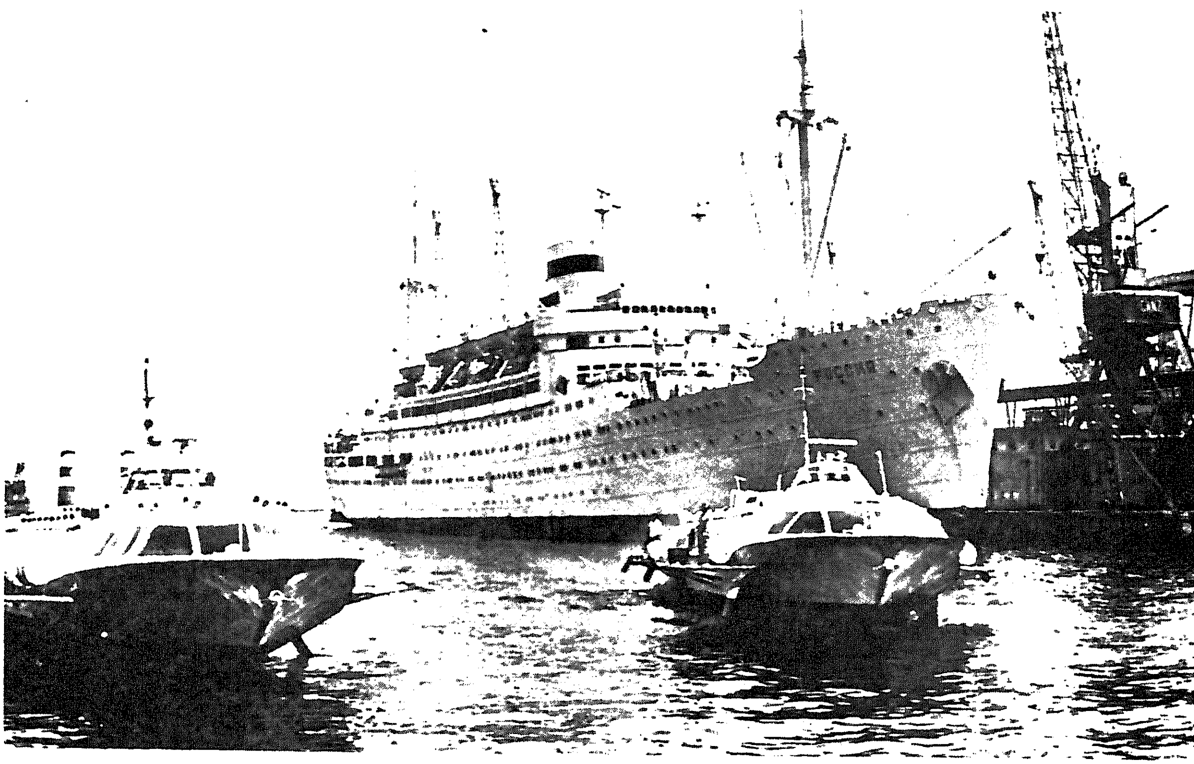

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Figure 2-6.—The Soviet passenger liner Russia moors at Odessa between transits while hydrofoil passenger craft move in the foreground. Several hundred commercial hydrofoils are used on Soviet lakes, rivers, and coastal seas, while a number of armed hydrofoils are operated by the Soviet Navy and Border Police. The craft shown here are also sold to other nations.

● A closely coordinated logistics force providing services on a regular basis to the Soviet Navy

● A worldwide network of intelligence collection

● A highly organized, closely controlled organization which can provide military support quickly and effectively; particularly in support of amphibious operations or arms movements

Overall, the Soviet Union is expected to continue to develop a multi-mission merchant marine which can compete economically in international markets and provide many other services in support of state policy, while maintaining the ability to respond rapidly to provide extensive military support. Thus, the merchant fleet provides the U.S.S.R. with a growing capability for the worldwide projection of political, military, and economic influence.

FISHING

The Soviet Union operates the world's largest fleet with more than 4,000 ocean-going vessels. The fleet's catch in 1975 exceeded 10 million tons. This placed the Soviets second behind Japan, and was almost three times the size of the U.S. catch.

Considerable resources have been invested in the fishing industry in the postwar period, with emphasis on the construction of large, ocean-going vessels equipped with elaborate fish-finding devices, processing facilities, and storage capacity. (See figures 2-7 and 2-8.)

The Soviets exploit fishing grounds throughout the world's oceans with large flotillas of ships. Groups of 100 to 200 trawlers are not unusual, and on occasion much larger formations have been reported. Trawlers which can handle up to 50 tons of fish per day also often have the facilities to filet, salt, can, or freeze the catch on board. Large factory ships and refrigerated cargo ships receive both processed and unprocessed fish from the smaller trawlers. The factory ships have the necessary processing and storage facilities aboard and transfer at sea their fish products to the cargo ships that take them to market. Little of the catch is wasted; that which is not processed into food and the waste is usually turned into fish meal or fertilizer by the factory ships.

These fishing flotillas are usually self-contained "communities," supported by specialized repair ships, tugs, tankers, and fresh water vessels. On occasion these ancillary ships also support naval activities. When a Soviet HOTEL-class ballistic missile submarine encountered serious engineering difficulties in the North Atlantic in 1972, the submarine was assisted for several days by fishing support ships.

Soviet fishermen are among the highest paid workers in the U.S.S.R. They are compensated for the hardships of long voyages and climatic extremes with annual paid vacations often exceeding 2 months. The industry is a major employer of Soviet naval reservists.

Most fish caught by the Soviet Union (over 90 percent) is for human consumption and eaten by the Soviet people or given as aid to Soviet client states. It has been estimated that 20 percent of the Soviet protein consumption consists of seafood. Exports include such delicacies as caviar, squid, and king crab. The last is caught in great quantities off the coast of Alaska, and has been the subject of controversy and several treaties between the United States and the Soviet Union.

The Soviet's large whaling fleet also has brought it (and that of the Japanese) into a running conflict with world conservationists seeking to save a number of whale species from extinction.

Since the Soviet fishing flotillas "invaded" U.S. coastal fishing grounds in 1961, there has been much debate of Soviet "vacuum cleaner" fishing methods and the damage these were doing to the U.S. fishing industry. The establishment in 1977 of a 200-mile economic zone around the United States has placed limits on the catch and strict control of fishing activities within the zone on foreign fishing ships. Several Soviet fishing vessels have been arrested by the U.S. Coast Guard for violating these controls. The Soviets are now faced with a number of these economic zones established by countries contiguous to traditional fishing grounds.

The "universality" of fishing has led to considerable export of Soviet fishing equipment and technology to other countries. Similarly, the Soviet Union has purchased fishing craft from Japan and other nations.

It is likely that there will be a continuing increase in the Soviet fishing industry in both quality and quantity. Indications are that in the near future the Soviets will be No. 1 in this area of maritime endeavor, which is increasing in

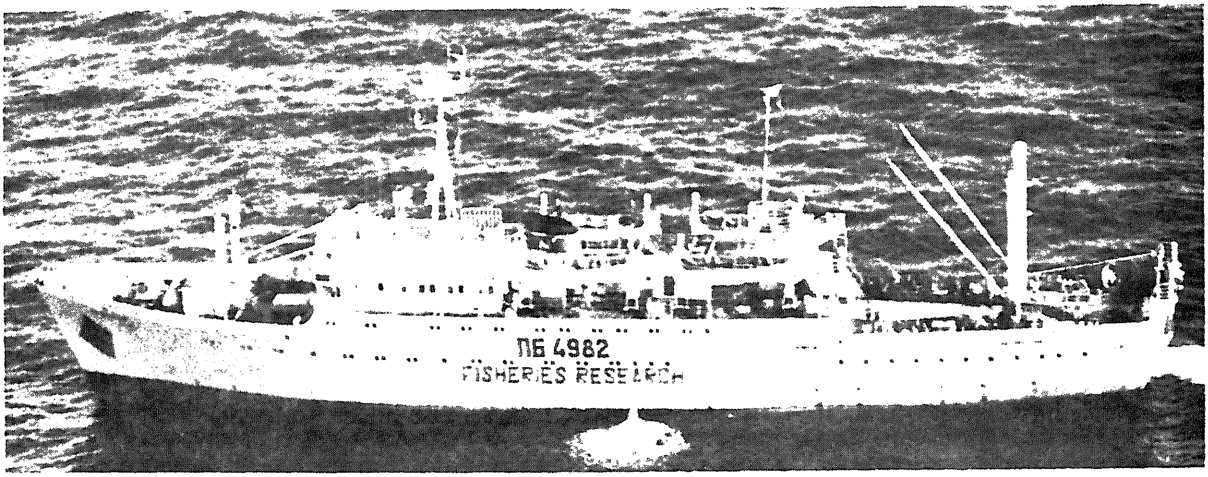

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Figure 2-7.—The Soviet fisheries research ship Ekvator is one of several larger research ships employed in specialized research for the Soviet fisheries industry. Similar dedicated ships support research and training for the Soviet merchant fleet, while others perform those functions for the shipbuilding industry and related activities. Soviet maritime endeavors are highly research oriented.

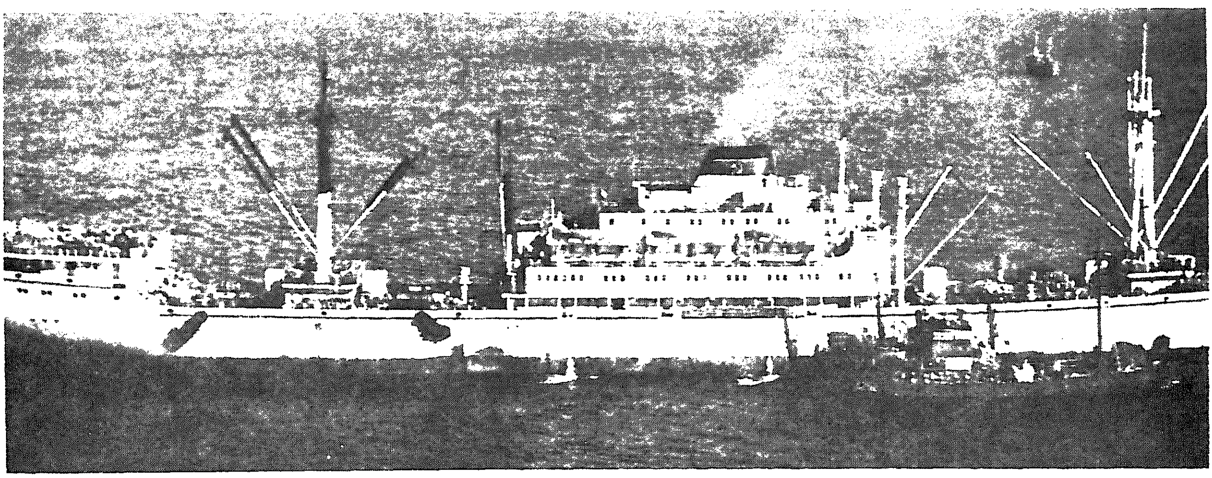

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Figure 2-8.—A Soviet "fish factory" ship operates with part of her brood of smaller fishing craft off Cape Cod in the western Atlantic. These large ships are floating bases and can completely process and can a catch on board. The Soviet Union has more that 4,000 ocean-going fishing craft and support ships, plus numerous inshore fishing boats, all directed by a centralized ministry.

importance as the earth's population grows and seeks additional animal protein.

RESEARCH AND SURVEYING

Soviet maritime activity is supported by a fleet of ocean research and surveying ships that is larger than that of the rest of the world combined, totaling over 200 ships. These ships are separate from the dedicated naval intelligence ships (AGI). Rather, they are engaged in academic and economic studies of the oceans. Several of these ships are Navy subordinated and manned by Navy crews, but the majority belong to civilian institutes concerned with ocean research and are civilian manned. Obviously, the civilian segments of

research activities have close ties with the Soviet Navy and, again, the officers of the civilian manned ships include a number of naval reservists.

In addtion, the Soviet Union operates a large number of Space Event Support Ships (designated SESS) that provide worldwide spacecraft and satellite tracking and recovery capabilities. (See fig. 2-9.) This extensive use of SESS units is in marked contrast to the U.S. policy of primarily placing space tracking stations ashore around the world.

Activities of the research, surveying, and space support ships are managed by the several institutes of the Academy of Sciences of the U.S.S.R. that direct scientific research. These institutes maintain close coordination with both the Navy and the Main Fisheries Administration, with the latter organization operating several research ships. During the 1960s two modified Navy submarines also were used for fishing research.

Soviet research ships are generally of modern design with most being of Polish or East German construction. Soviet research ships vary in size from small coastal craft to the giant *Kosmonaut Yuri Gagarin*, a 45,000-ton ship fitted with elaborate equipment for research into the upper atmosphere and support of space events. (See figures 2-9 and 2-10.)

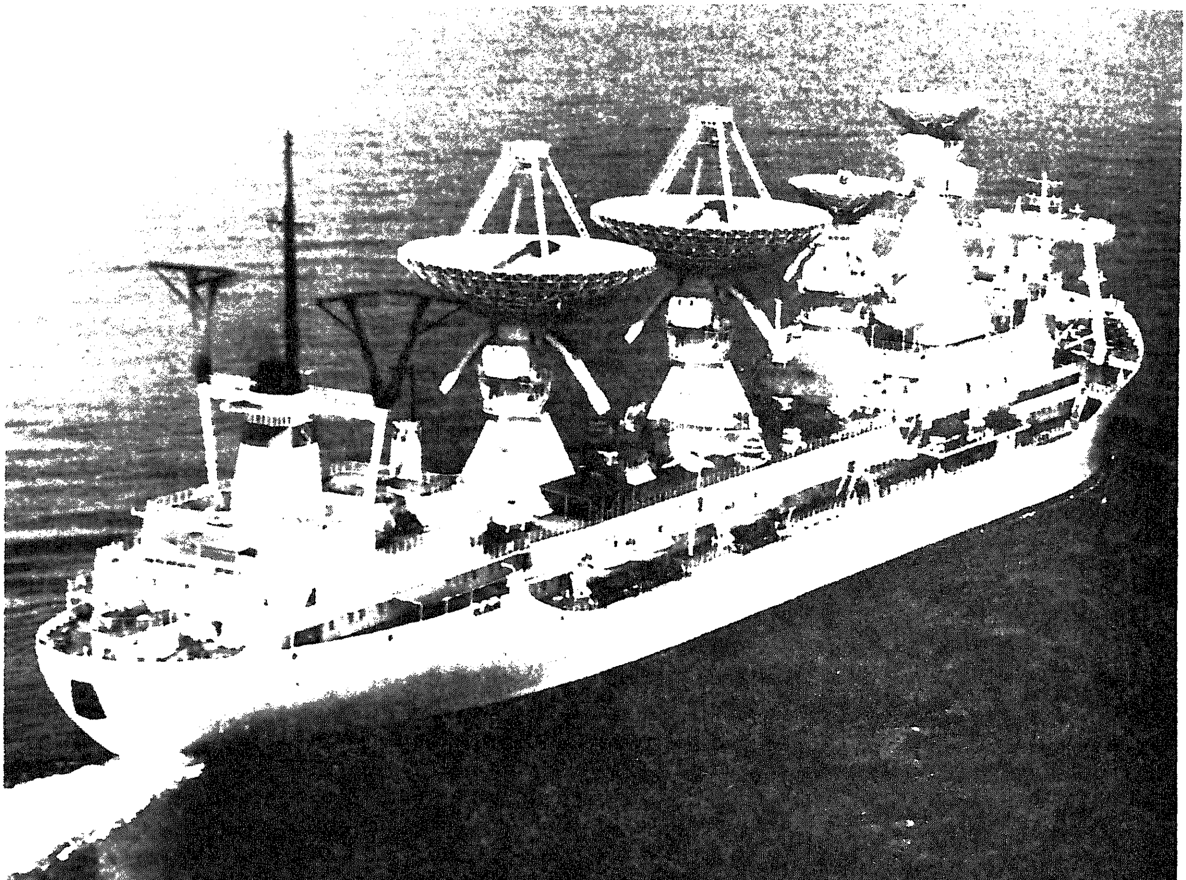

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Figure 2-9.—The Soviet satellite tracking ship Kosmonaut Yuri Gagarin is one of a fleet of Soviet Space Events Support Ships (SESS) which are employed in civilian and military space and missile programs. The large, sophisticated ships of this type have secondary intelligence collection and political presence capabilities. Most of these ships are operated by civilian research institutes, with a few others being Navy manned.

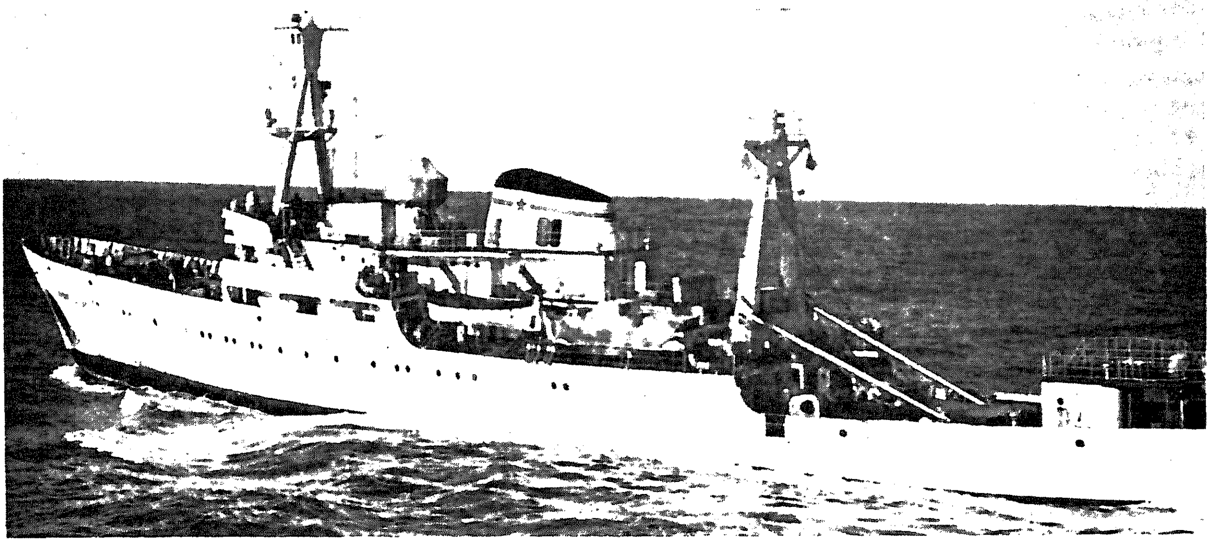

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Figure 2-10.—The oceanographic research ship Gavril Saritshev is a large, modern oceanographic research ship. The Soviet ocean research fleet supports all Soviet maritime activities, including the Navy. The oceanographic research ships are operated by the Navy and by a number of specialized research institutes and the maritime-oriented ministries. Some of these ships are of the same class as naval intelligence collection ships.

SHIPBUILDING

The current Soviet shipbuilding industry evolved after World War II when the devastated yards of the Baltic and Black Sea coasts were rebuilt and new yards were constructed (or enlarged) on the northern and Pacific coasts to make those naval fleets independent of the traditional European yards.

Today the Soviet Union has 18 large shipyards, each employing 2,000 workers or more on a full-time basis. They rank as one of the world's largest producers of ships. However, because of Soviet emphasis on small merchant ships and fishing craft, the Soviets tonnage production is small for the number of ships produced.

Besides the output of a large indigenous shipbuilding industry, the Soviets also purchase considerable merchant and naval tonnage from foreign yards: naval ships, particularly amphibious ships and auxiliaries from Poland, Finland, and East Germany; and merchant and fishing ships from the aforementioned countries and others, including Japan, West Germany, Sweden, and Great Britain.

Soviet submarine production is accomplished at Severodvinsk on the White Sea, the largest submarine building complex in the world; at Komsolmolsk, well up the Amur River near the Pacific coast; at Gorkiy, which is in the center of the U.S.S.R.; with ships moving to the open sea via the extensive Soviet inland waterway system; and, at the two-yard United Admiralty complex in Leningrad. It is estimated that these yards contain physical facilities large enough to produce 20 to 25 nuclear submarines a year on a single-shift basis, if priority were given to allocating necessary resources and labor from other sources. The Soviets have been averaging about 10 to 12 new submarines annually, mostly nuclear-powered, over the last several years.

Principal surface combatants are primarily built in Leningrad and Kaliningrad on the Baltic Sea, and Nikolayev near the Black Sea where the KIEV-class carriers are being built. A number of other yards are involved in the construction of lesser combatants and other types of naval ships.

Most of the shipyards involved in naval construction also build merchant or fishing ships. The construction of all ships, naval or commercial, in the Soviet Union is managed by a single

Ministry of Shipbuilding. This ministry is responsible for all yards of significant size and for most research, design and useful exchange of technologies and for the coordinated allocation of resources. Each aspect of ship design, construction, and specialized equipment is supported by a specialized research institute.

New shipbuilding equipment, from a simple hand tool to a computer-controlled cutting machine, must be approved by the Ministry of Shipbuilding before it is introduced into the industry as a standard item. Similarly, techniques initially employed for warship construction (such as modular assembly of components on a floating platform) subsequently are applied to commercial shipbuilding.

The Soviet yards make extensive use of modern shipbuilding techniques and technologies. According to a U.S. Navy report on the subject: "In formulating a judgment on U.S.S.R. progress in automation of (ship) production. . . .most of the publicized innovations are related to yards doing merchant work of a far more open nature and considerably lower priority than Soviet naval work, and it can therefore be presumed that in yards engaged in high priority work on naval ships, the facilities, equipment, and technology are at least equal and probably superior. . ." Various Soviet shipbuilding management and production techniques that have been observed have led to the conclusion that the Soviets have established a very strong and viable shipbuilding industry.

In addition to building naval and commercial ships for Soviet use, Soviet shipyards have produced ships of both categories for other nations in the Soviet bloc, western Europe, and the Third World.

SUMMARY

The rapid growth and continuing expansion of Soviet maritime strength must be viewed in historical perspective before the full implications of the economic, political, and military threat to the West can be assessed. In that perspective, the dramatic rise of Soviet naval and commercial capabilities in the past decade is an unprecedented development in the history of sea power and trading nations.

It has been demonstrated that balanced sea power is an essential ingredient of a flexible national strategy. Sea power is selective of time and place in its application and discriminate in the means and degree with which it can be used. U.S. naval forces can meet any type of aggression from the most primitive to the most sophisticated. The variety of options inherent in today's Navy is in itself a strong deterrent. If deterrence fails, however, these same forces will permit the United States to counter armed conflicts within selected limits.

But, as the definition at the beginning of this chapter stated, sea power is more than military power at sea. To place U.S. maritime power in the proper perspective, it is necessary to examine the "fourth arm of defense," our merchant marine industry.

CHAPTER 3

U.S. MERCHANT MARINE

Once the United States produced more raw materials than it consumed. This is no longer true. For decades we had a surplus of raw materials, but we have now become a nation deficient in many essential raw materials.

If the United States maintains its present economy, we must have at least 77 different resources. For example, manganese is needed to make steel; we import 100 percent of that metal. Columbite is used in the construction of nuclear reactors as a stabilizer in stainless steel and for the manufacture of rockets and missiles. We import 100 percent of the columbite we use. We import 86 percent of our country's bauxite from which aluminum is refined. We import 100 percent of the chromite used to toughen steel and other defense materials and more than 99 percent of the tin needed. In addition, the United States annually consumes almost one third of the entire world's supply of oil.

Of the 77 vital resources, only 11 are found within the borders of the United States. The remainder are globally dispersed and must come to this country by the sea. The sea is without rival in allowing effective movement of bulk materials. It is the key avenue along which millions of tons of imports reach our production lines. Figure 3-1 contrasts the United States reliance on imported raw materials with the Soviet Union's self-sufficiency. Should we become isolated from the rest of the world and our stockpile of raw materials become depleted, the consequences would be severe indeed. The operations of our basic industries would be sharply curtailed because of the lack of critical materials. In turn there would be a reduction in our capacity to manufacture equipment, including ships, aircraft and electronics products, all so essential to our national defense.

Just as this country's industry relies on imports, other nations are dependent upon waterborne commerce to deliver American raw materials, farm products, and manufactured goods needed to keep their economy healthy. This global industrial interdependence is made possible by rapid and efficient ocean transportation.

The amount of the two-way foreign trade involving the United States is steadily increasing. Between 1967 and 1975, the U.S. import/export volume increased by over 50 percent (to 696.6 million short tons), while the value of this trade more than tripled (to $129.9 billion). Despite major improvements in air transport capabilities, ships were still carrying 99.8 percent by weight (86 percent by value) of American imports and exports. Indications are that international ocean trade will continue to increase.

Contrasting with this, however, has been the decrease over the years in the U.S. merchant marine's share of this ocean carriage. In 1960 U.S. flag merchant ships carried 11.1 percent of the tonnage and 26.4 percent of the value of the U.S. waterborne export and import cargoes. By 1977 this share had declined to only 4.5 percent of the tonnage and 16.4 percent of the value.

To achieve our national objectives in time of war and to support our way of life in time of peace, we require certain assurances. First our nation must be assured that it will always have supplies of raw materials adequate to its needs. As these raw materials will be transported on the ocean, we must also be assured that the sea lanes will be kept open and secure. Keeping our sea lanes open is a vital role of the U.S. Navy. Ensuring that essential cargos are carried to this country is a task that would fall to our merchant marine should the foreign merchant ships upon which we rely refuse to continue their service in time of war or international tension. It is appropriate, therefore, to review the capabilities and contributions of the U.S. maritime industry.

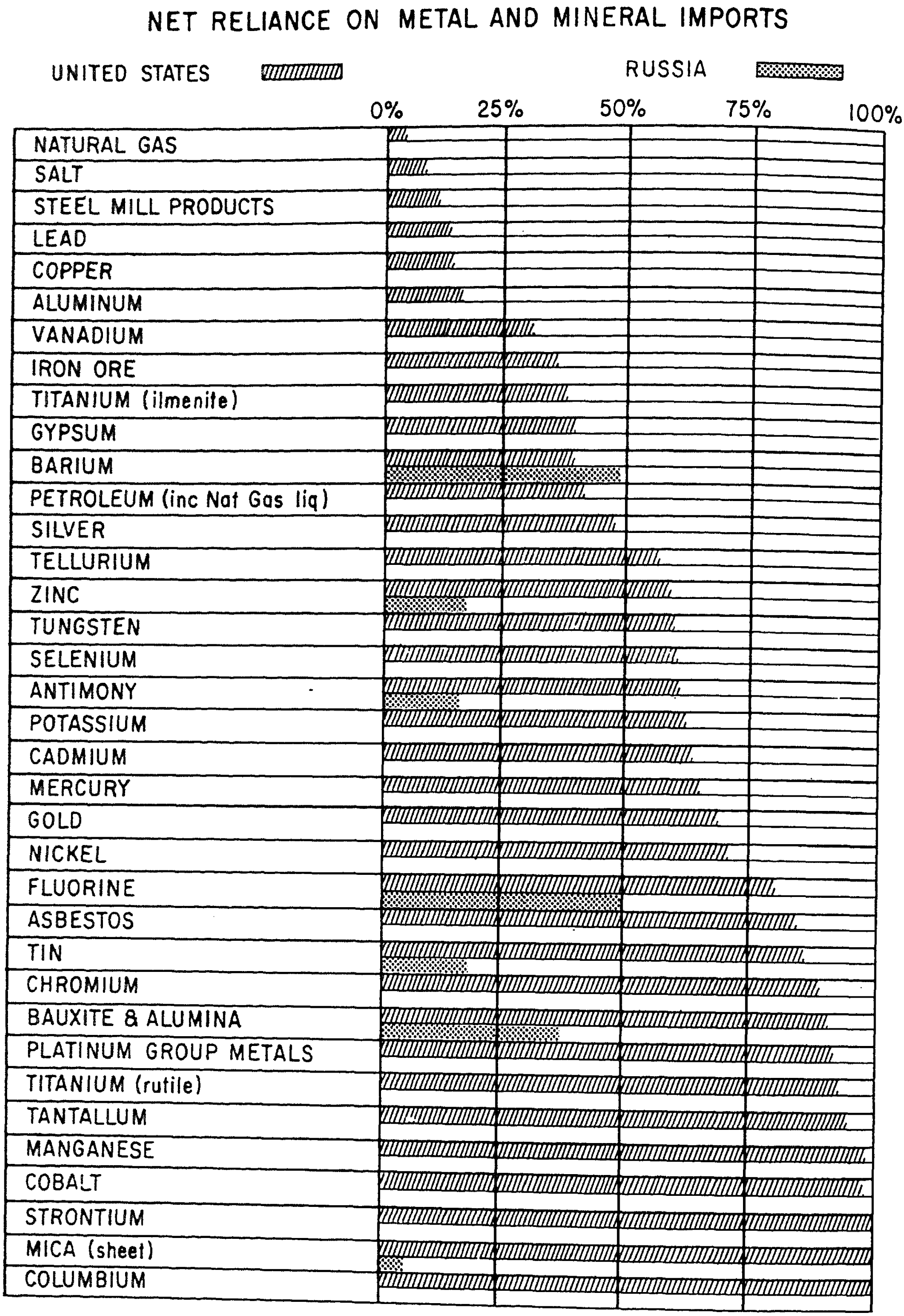

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Figure 3-1.—The United States reliance on imported raw materials compared with the Soviet Union's self-sufficiency.

American shipping has emerged from the period of leftover war-built ships. The lean years of past programs seem to be over. It is evident, however, that the U.S. merchant marine has a great deal of catching up to do to keep pace with foreign competition.

The war-built ships were not constructed for competitive service. The heady days of huge cargos supplied to foreign nations under the Marshall Plan and other U.S. assistance programs came to an end. Modern larger and more competitive general cargo freighters, bulk carriers, and tankers were being built by allied nations to replace the war-built ships purchased from the United States and by former enemy countries so they could again become strong contenders in ocean transportation. The war-built ships found their way to many newly-created nations that were emerging in Asia and Africa intent on developing their own merchant fleets.

Meanwhile, the U.S. merchant fleet, comprised largely of war-built ships, had been stagnating as a result of increasing competition from foreign shipping. Efforts to overcome block obsolescence through an American shipbuilding program in the 1950s and 1960s were not very successful.

There are two U.S. flag merchant fleets. The largest is privately-owned and operated. The other is under the control of the Navy's Military Sealift Command (MSC); the inactive consists of ships in the National Defense Reserve Fleets at Atlantic, Gulf, and Pacific Coast sites maintained by the Maritime Administration. The government fleet will be discussed in the next chapter.

PRESENT STATUS

Merchant ships are divided into five major types; general cargo or break-bulk freighters, bulk dry cargo carriers, tankers, combination passenger/cargo ships that carry up to 125 passengers, and passenger ships carrying more than 125 passengers and relatively little cargo. Within these major groupings there are as many as 43 specialized and combination vessel types classified by the Maritime Administration. Each was developed to move specialized cargo efficiently at the lowest possible cost to the operator and ultimately to the buyer of shipping services.

In 1977, the U.S. flag privately-owned merchant marine consisted of 577 ships totaling 16.5 million deadweight tons (dwt). They are comprised of 20 types made up largely of general cargo freighters, containerships, partial containerships, barge carriers known as LASH (fig. 3-2)

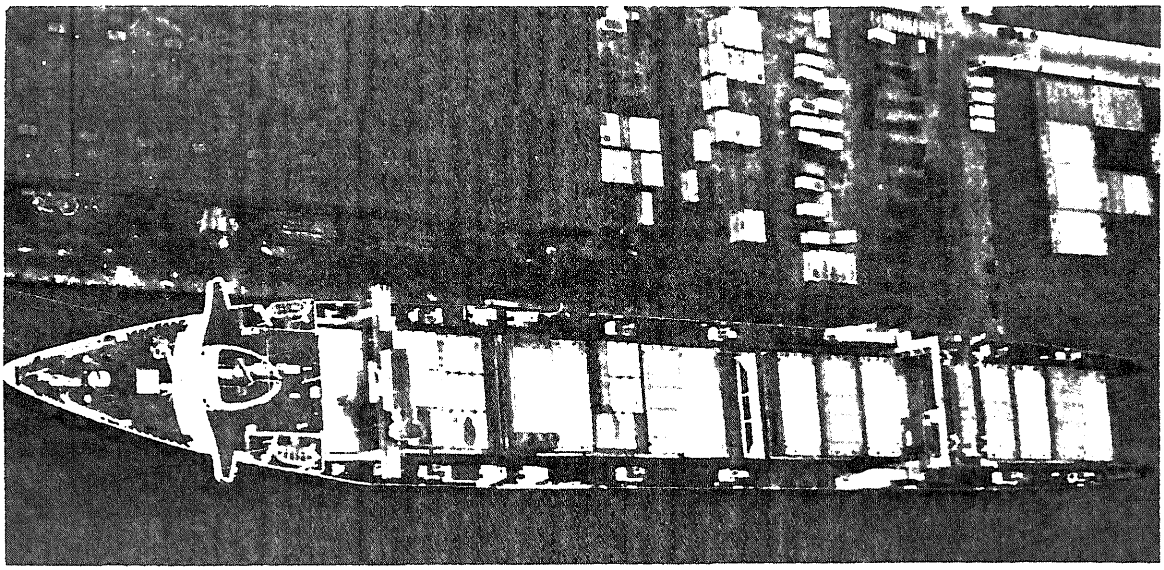

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Figure 3-2.—Delta Steamship Lines Delta Norte, 40,000 dwt. LASH Vessel, at her berth in New Orleans.

Table 3-1.—Types of U.S. Privately-Owned Merhcant Ships

U.S. Privately Owned Merchant Marine*
by Type of Ship
as of 1 January 1983 and 1 July 1983
(dwt in thousands)

Type of Ship	1 January 1983 No.	1 January 1983 Dwt	1 July 1983 No.	1 July 1983 Dwt
Freighter	52	640.8	52	640.8
Bauxite Carrier	0	0	0	0
Bulk Carrier	16	443.3	13	378.1
Bulk/Oil	2	78.4	3	271.2
Collier	1	24.3	1	24.3
Combination Pass./Cargo	4	27.2	4	27.2
Combination/Reefer	4	37.4	4	37.4
Containership	99	1,926.0	97	1,866.8
Container/Barge Carrier	18	682.1	21	771.5
Container Car Carrier	2	36.1	2	36.1
Container/Ro-Ro	0	0	0	0
Int. Tug/Barge (Tank)	11	405.9	13	501.9
Int. Tug/Barge (Bulk)	4	99.4	4	99.4
Partial Container	53	756.3	53	758.7
Roll-On/Roll-Off	23	329.8	27	445.5
Ore/Bulk/Oil	2	164.4	2	164.4
Tanker	252	14,734.2	246	14,639.7
Asphalt Tanker	2	31.4	2	31.4
Chemical Tanker	6	164.8	6	164.8
LNG Tanker	13	928.1	13	936.4
LPG Tanker	3	84.4	3	84.4
Sulphur Tanker	5	113.3	5	113.3
Total	572	21,707.6	571	21,993.3

3 containerships that have been reclassified as barge carriers.
*1,000 gross tons and over.

284.56

and SEABEE ships, (fig. 3-3) tankers, bulk carriers, roll-on/roll-off (Ro/Ro) ships, and chemical tankers (table 3-1).

The area of employment of the 577 ships showed a wide divergence between the areas served by the dry cargo and tanker fleets. Almost 80 percent of the dry cargo fleet was employed on U.S. foreign trade routes to every area of the world. In contrast, about 65 percent of the tanker fleet was employed in the domestic trades, the majority from Gulf Coast to Atlantic Coast ports.

INNOVATIONS IN SHIP DESIGN

American shipping companies have been the innovators in developing faster and technologically advanced merchant ships. For decades in the nineteenth century the legendary clipper sailing ships showed their wakes to the ships of other nations and dominated ocean trade routes. Because of their speed, the *Mariner* type freighters aroused competitive concern from foreign steamship lines and forced them to follow the American lead. The containerships, developed by American operators in conjunction with the technological

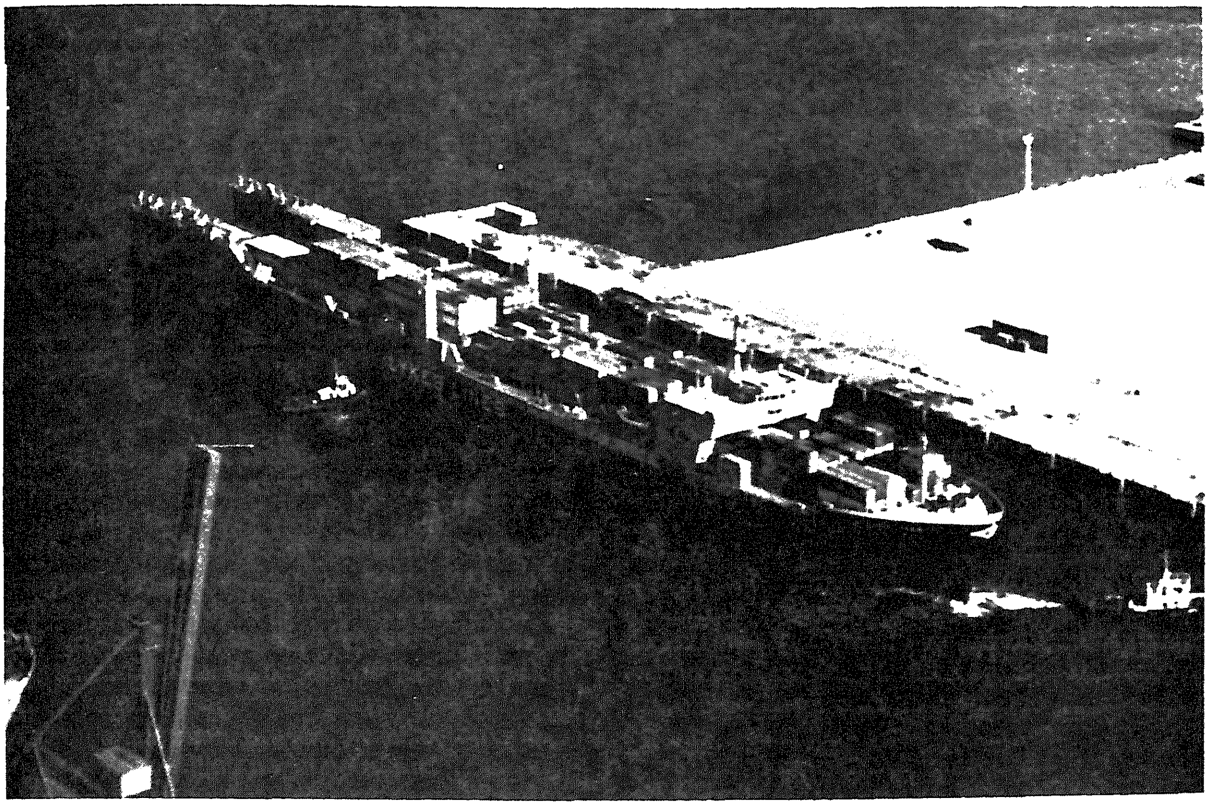

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Figure 3-3.—Lykes Brothers' Doctor Lykes, a Seabee Class barge container and heavy-lift ship, arrives in Bilbao, Spain.

know-how of U.S. shipbuilders, revolutionized the general cargo trades, as did such other speciality ships as the Ro/Ro's LASH and Seabee barge carriers.

Of the 431 full containerships totaling 6.3 million dwt in the world fleet on January 1, 1975, the U.S. flag privately-owned merchant marine had 110, totaling 1.8 million dwt, or 25 percent of the number and almost 30 percent of the tonnage. Eight of the U.S. flag containerships are the world's fastest, capable of 33 knots, and are demonstrating their competitive effectiveness on U.S. Atlantic and Pacific trade routes. Other nations have had to follow the American initiative in these developments.

If American shipping companies were innovative in developing more productive vessel types, they have not always been successful in marketing their advantage with American shippers. As a consequence, their initial advantage was not sustained, for foreign nations soon adopted these more productive ship types, built them in large numbers, and continued to dominate the market for American cargos moving in foreign trade.

FLAGS OF CONVENIENCE

American shipowners have operated ships under foreign registry for the past 160 years. The number and tonnage was never large until the outbreak of World War II. By 1941 the allied positions had deteriorated sharply. Their shipping had suffered severe losses as a result of German submarine actions. It was in this scenario that all possible aid from the United States was requested. But Lend-Lease and other military and civilian aid could not be shipped in American flag ships under the rigid restrictions of the Neutrality Act of 1939.

With the government's active encouragement, American shipowners transferred a number of their ships to the friendly registries of neutral Panama and Honduras. Shipping was made available to carry the military and civilian supplies from this country overseas. Both sides

benefited; American agriculture and industry benefited from increased sales and earnings; allied soldiers and civilian populations benefited from shipments of military equipment, food, and civilian supplies. When the U.S. entered the war, those ships that were not sunk and increasing numbers of others that were transferred to Panamanian and Honduran registry came under United States control.

It was the foregoing arrangement that initially gave rise to the concept of "Effective United States Control" (EUSC) of merchant shipping. By 1948 the EUSC concept was adopted by the Department of Defense. Transfers of war-built merchant ships to Panamanian, Honduran, and Liberian flags were encouraged under the Maritime Administration's "Trade-Out-and-Build" program, so they could be replaced by modern and competitive ships. Although the purpose of the program was to promote increased shipbuilding activities, it was not successful. Nonetheless, transfers to these flags of convenience continued. In conjunction with the Defense Department's use of the EUSC concept in its military planning, war-risk insurance was made available to EUSC ships under specific restrictions by the Maritime Administration.

Most of the ships were built or "jumboized" in Japanese and European shipyards and operated with foreign officers in almost all instances and foreign seamen in every case. It is not unusual to find an EUSC ship manned by deck officers of one nationality, a mixed European crew speaking different languages, and still another mixture of nationalities and languages in the engine room. Although the concept of EUSC implies that these ships would be available to the United States in the event of a national emergency, the problem of availability is very much open to question.

Advantages to the Shipowners

As the United States became more dependent upon foreign sources for its energy fuels and industrial raw materials, American oil companies and basic industrial manufacturers ordered their ships from lower cost foreign shipyards and sought havens for them under flags of convenience.

Based on their experience of operating ships under Panamanian and Honduran registries before and after World War II, American citizen parent corporations had learned how advantageous such operations could be. For example:

1. They would not have to contend with American maritime unions and could employ foreign crews at much lower wage rates.
2. Lower capital costs, maintenance, food, and other expenditures reduced their overall operating costs substantially.
3. Tax benefits were substantial. Taxes were paid only to register their ships in Panama, Honduras, or Liberia and these were nominal, as were the required annual fees for the ships. Vessel earnings were not taxed by these countries, and money could be saved by avoiding or deferring payment of U.S. taxes. This tax shelter has now been modified by a provision of the 1975 Tax Reduction Act.
4. Shipowners could improve considerably their financial ability to buy new ships as a result of increased tax benefited earnings.
5. Operations of their ships were not restricted by the same regulations imposed by the U.S. government, especially Coast Guard regulations regarding vessel safety.
6. Their operational flexibility was unhampered. Ships could trade wherever the best opportunities afforded without let or hindrance from the U.S. government except in the domestic trades of the United States.

By 1977, as a consequence of these factors and as world oceangoing trade expanded, the so-called EUSC fleet grew in size to 45.9 million dwt, or 2.8 times the U.S. flag privately-owned merchant marine (table 3-2). U.S. citizen wholly-owned or controlled ships comprise approximately 28 percent of the entire tonnage of the Liberian flag fleet, 21 percent of the Panamanian fleet, and 91 percent of the Honduran fleet.

It should be noted that tankers comprise the largest number and tonnage of the EUSC ships. They range in size from comparatively small tankers of less that 20,000 dwt to the ULCCs of 326,000 dwt. While there are a large number exceeding 200,000 dwt, the majority are of a size that can readily serve practically all major U.S. ports. Bulk and ore carriers average about 57,000 dwt. With the few exceptions of those exceeding 150,000 dwt, they, too, can enter most U.S. major ports.

Disadvantages to the United States

Weighed against the advantages to U.S citizen companies in operating EUSC ships are the

Table 3-2.—Types of U.S. Privately-Owned and EUSC Flag Ships

U.S. Privately-Owned and EUSC Flag Ships, by Type*
as of 1 July 1982
(dwt in thousands)

	Total		Tankers		Bulk Carriers**		Freighters***	
Flag	No.	Dwt	No.	Dwt	No.	Dwt	No.	Dwt
U.S.	573	21,563.2	293	16,414.3	25	713.3	255	4,435.6
EUSC (Total)	466	47,221.8	286	40,219.7	106	6,466.6	73	525.6
Liberia	363	40,673.2	230	34,502.2	89	5,174.5	44	396.6
Panama	96	6,498.1	56	5,717.6	17	692.0	23	88.5
Honduras	7	50.4	0	0	0	0	6	40.5

*Excludes combination passenger/cargo ships.
**Includes ore and other bulk carrier ships.
***Includes all types—containerships, RO/RO, LASH, SEABEE, reefer, general breakbulk, etc.

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disadvantages to U.S. economic, political, and military positions.

1. The tax losses that were sustained by the U.S. Treasury have probably been substantial. Prior to a 1975 change to the tax laws, earnings of U.S. parent companies' foreign shipping subsidiaries were not taxed until they were returned as dividends to the U.S. parent company. This was a special situation not otherwise available to U.S. foreign sales or service subsidiaries. Earnings were allowed to be invested without restrictions in foreign enterprises and withheld for years, used to build new ships in foreign shipyards to the detriment of U.S. shipyards and support industries, or brought back to balance a loss in parent company earnings to reduce the tax return to the government. These benefits are no longer as substantial as in the past.

2. The fact that EUSC ships play an important role in U.S. military mobilization planning is based upon agreements with Panama, Liberia, and Honduras that ships of U.S.-controlled foreign affiliates of American citizen companies registered in those countries will be returned to U.S. control in time of national emergency or war. This may be so as long as friendly relations continue. In recent years, however, many governments of the Third World have experienced political upheavals, particularly in Latin America and Africa. Under international law, only the state of registry has the right to requisition and exercise control of its national flag ships. This is something to think about especially when the majority of the EUSC ships never enter U.S. ports but trade worldwide. Military mobilization plans also give credence to the contracts between the U.S. owner transferring his ship to flag of convenience registry and MARAD, whereby he agrees to make his ship available for requisition by the United States in event of a national emergency and gives a bond to that effect. Most of the EUSC ships, however, trade between third countries. Their crews are of mixed nationalities whose political views may not be in agreement with U.S. government policies. Given this set of circumstances, requisitioning a ship may not always be possible.

3. Perhaps the most serious of all considerations concerning the EUSC fleet is that it does nothing to promote a U.S. merchant marine. In fact it is detrimental. By building overseas the tankers and bulk carriers that would give balance to an American merchant fleet, the EUSC ships create a dichotomy of interests between the civilian and military concepts for merchant shipping that is not resolved by the promise of availability.

Despite these differences in concept, American parent corporations continue to build large numbers of tankers in foreign yards for so-called EUSC operations. Data prepared by the Maritime Administration in 1974 shows that 23 U.S. citizen corporations had on order or under construction in European and Japanese shipyards 100 tankers totaling 23 million dwt for intended registry under Liberian and Panamanian flags. At least 60 of the tankers ranging between 200,000 and 446,000 dwt could not enter U.S. ports because of their size and would be of minimum or no value in time of war.

GOVERNMENT ASSISTANCE

Confronted by the national security requirement for a substantial merchant fleet and the increasing use of foreign and EUSC ships, how does the United States government attempt to maintain and strengthen the American merchant marine? It does so by providing direct and indirect assistance to the maritime industry.

DIRECT AID

Under the provisions of the Merchant Marine Act of 1936, as amended in 1970, the Maritime Administration, within the Department of Commerce, is responsible for the disbursement of about $500 million annually in construction and operating differential subsidies. These direct payments to American shipbuilders and ship operators are granted to encourage the continued existence of a U.S. shipbuilding capacity and the maintaining of a privately-owned U.S. flag merchant fleet capable of competing effectively for the carriage of a substantial share of cargoes in the U.S. foreign trade.

Subsidies are designed to achieve parity with foreign operators who, because of generally lower standards of living, benefit from lower wages and other costs. Subsidies, therefore, offset the competitive cost advantages foreign shipbuilders and ship operators enjoy.

Construction Differential Subsidy (CDS)

This subsidy, since discontinued, encompassed the difference between the shipbuilding costs in an American shipyard and the estimated cost of constructing the same ship in a foreign shipyard. The amount of subsidy may not in any case have exceeded 50 percent of the domestic shipbuilding costs.

To be eligible for CDS, a vessel must have been built in an American shipyard owned by American citizens, manned by an American crew, and operated under the U.S. flag in foreign commerce.

As of September 30, 1978, 24 of the 48 new merchant vessels on shipyard order books were being built with CDS. The total subsidy to be paid by the government, $552 million, represents less than one third of the total construction costs. The last ship built under this program, the *Falcon Champion*, a 666 foot, 33,600 dwt petroleum products tanker, was launched 10 September 1983.

Operating Differential Subsidy (ODS)

The objective of the ODS program is to achieve cost parity in seaman's wages, vessel insurance, and maintenance and repairs not covered by insurance. This is to ensure that American shippers will have regular and frequent service between the United States and overseas markets at a reasonable and competitive freight rate.

This subsidy does not guarantee the ship operator a profit. Once parity is achieved, it is up to the management to earn a profit or take a loss on its own merits.

To receive ODS the companies must assume rigid long-term contract obligations, including ship replacement programs that will amount to hundreds of millions of dollars. They must operate under strict operating limitations as to trade routes and services and number of sailings on a scheduled basis. Financial obligations are involved in that the companies must place a part of their earnings in capital reserves for use in vessel replacement, thus reducing the amount of earnings available for dividends.

Prior to the 1970 Merchant Marine Act, the only ships eligible for operating subsidy were freighters and combination passenger/cargo ships built in American shipyards for employment in scheduled or liner service on U.S. essential foreign trade routes. The 1970 Act has given elasticity to the former rigid formula for subsidy eligibility. Title VI of the Merchant Marine Act, 1936, as amended by the 1970 Act, provides the new conditions for including other ship types, such as tankers and bulk carriers. Thus, the 187 presently subsidized ships not only consist of an increasing number of the most productive vessels but also constitute a better balanced and competitive fleet. (table 3-3).

The nonsubsidized U.S. flag fleet has twice the number of ships and three times the tonnage because of the preponderance of tankers in this segment. Most of the freighters and bulk carriers are the remnants of the war-built fleet whose average age exceed competitive economic usefulness. Many of the tankers are also in the latter category, but this group is being leavened by new tankers as a result of the opening of the Alaska pipeline. Those tankers that are being delivered are of "handy" size capable of being accommodated at major U.S. ports. Intermodal type ships are the bright aspects of this group. They include full containerships, Ro/Ros and LASH types employed in the foreign, coastwise,

Table 3-3.—U.S. Subsidized Fleet

U.S. Subsidized Fleet
as of 1 January 1983

Vessel Type	No.	Dwt	Average age
Combination Pass./Cargo	4	37,400	19.2
Freighters	143	2,789,900	10.1
Bulk Carriers	2	164,400	5.7
Tankers	20	1,192,100	2.3
Total	169	4,485,800	9.3

284.58

Table 3-4.—U.S. Nonsubsidized Fleet

U.S. Nonsubsidized Fleet
as of 1 January 1983

Vessel Type	No.	Dwt	Average age
Combination Pass./Cargo	4	27,200	2.0
Freighters	104	1,581,200	24.3
Bulk Carriers	23	612,300	31.2
Tankers	273	15,242,200	17.4
Total	404	17,462,900	21.6

284.59

and noncontiguous trades. Overall, however, the ships in the nonsubsidized group are, on average, twice as old as the subsidized segment of the merchant marine. (table 3-4).

INDIRECT AID

Practically all maritime nations offer various forms of indirect aid to their shipbuilding and shipping industries. In the United States, MARAD administers three major types of such assistance: capital construction funds, the ship financing guarantee program, and government generated cargoes. In addition, merchant ships in the domestic trade benefit from cabotage laws.

Capital Construction Fund (CCF)

Since the Capital Construction Fund was established under the Merchant Marine Act of 1970, it has become one of the major government aid programs extended to the many sectors of the U.S. merchant marine. CCF assists operators in accumulating capital to build, acquire and reconstruct vessels through the deferment of federal income taxes on eligible deposits. With the high costs of ship construction today, the availability of CCF as a source of capital has taken on significant importance.

The CCF program has broad applicability, which enables operators to build vessels for the U.S. foreign trade, the Great Lakes trade, the noncontiguous domestic trade, or the fisheries of the United States. Thus vessels built under this program span a wide spectrum including large container ships, tankers, sophisticated LNG vessels, bulk carriers, offshore vessels, and barges.

Since the inception of this program in 1971, $1.4 billion has been deposited in CCF accounts and over $1 billion has been used for the modernization and expansion of the United States merchant marine.

Ship Financing Guarantees

Title XI of the Merchant Marine Act of 1936 established the Federal Ship Financing Guarantees Program. As originally enacted, Title XI authorized the Secretary of Commerce to ensure loans or mortgages made to finance or refinance the construction or reconstruction in U.S. shipyards of American flag vessels. (See fig. 3-4.) In 1972, Title XI was amended to provide direct government guarantee of the underlying debt obligation for future transactions.

In the event of default by the vessel owner, the U.S. government ensures or guarantees full payment to the lender of the unpaid principle and interest of the mortgage or obligation.

The self-sustaining Title XI program has been one of the most successful under the 1936 act. Its total costs, including the salaries of the MARAD staff employed in administering it, are underwritten by fees which are paid by users.

Government Generated Cargo

The cargo preference system is a major form of federal assistance to the U.S. shipping industry. This assistance is given through the cargo preference laws, a group of federal statues that requires not less than a stated fraction of government generated cargo must be carried in U.S. vessels. Although there exist a number of separate cargo preference laws, including some that were simply provisions in acts establishing foreign assistance programs, three preference laws are of primary importance today and affect nearly all cargoes that are subject to the preference laws.

The oldest current preference law is the Military Transportation Act of 1904. It directs that all supplies for the U.S. armed services that move by sea must be carried either in vessels of U.S.

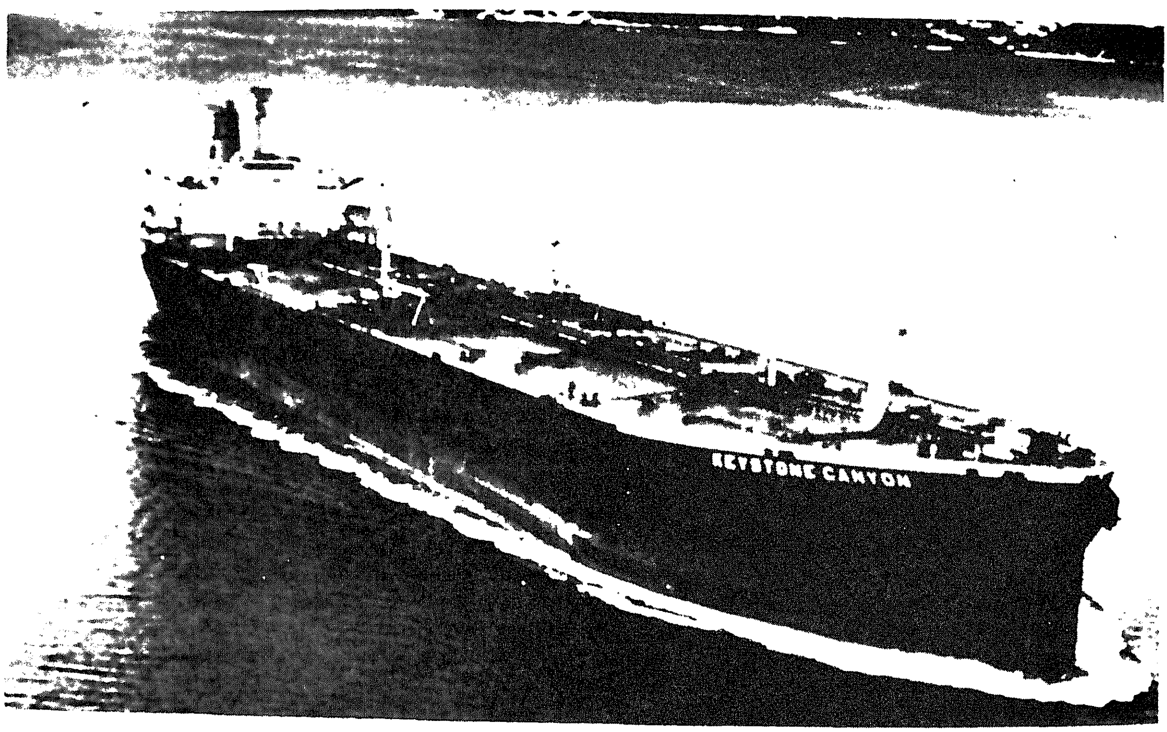

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Figure 3-4.—Keystone Canyon arrives at Valdez to take aboard another load of Alaskan oil. 164,000-dwt. tanker, built at Avondale Shipyards for SOHIO under Title XI ship financing guarantees program, began trading regularly between Valdez and Parita Bay, Panama, in February 1978.

registry or in vessels owned by the United States. Exceptions are allowed only when the freight charged by U.S. vessels is "excessive or otherwise unreasonable." Although the statute affords no warrant for the practice, the Defense Department occasionally engages foreign vessels to move its supplies when U.S. vessels are not available.

Public Resolution No. 17 of the Seventy-third Congress, approved in March 1934, declared it to be "the sense of Congress" that whenever loans were made by an agency of the government to foster the export of U.S. products, those products should be carried exclusively in vessels of the United States. Although the resolution technically may not have the force of law, it is treated in practice as imposing a legal requirement that at least one half of the exports to which it applies must be carried in U.S. bottoms.

Public Resolution 17, or P.R. 17, is the least important of the three principal cargo preference laws and affects only exports that are financed by the Export-Import Bank of the United States. If P.R. 17 were honored to the letter, all shipments financed by the Export-Import Bank would have to be carried in U.S. vessels. Usually this requirement is waived, however, and foreign flag vessels are permitted to carry up to one half of such exports.

During the postwar period Congress enacted a number of programs providing military and economic assistance to friendly countries overseas. Several of the acts establishing these programs contained cargo preference provisions that reserved to U.S. ships the carriage of at least part of the cargoes to be moved abroad. These provisions were largely superseded by the Cargo Preference Act enacted in 1954 as an amendment to the Merchant Marine Act of 1936.

The act covers three classes of goods: goods bought by the government for its own account; goods provided by the government for the account of any foreign nation, if no provision is made for reimbursement; and goods for which the government has advanced funds, granted credits, or guaranteed the convertibility of foreign currencies.

The statute directs that whenever such goods are moved by sea, at least 50 percent of the shipments, by gross tonnage must be carried in privately-owned U.S. flag commercial vessels, provided such vessels are available at fair and reasonable rates. A few minor cargos are expressly exempted. The act provides that its requirements may be waived whenever Congress, the President, or the Secretary of Defense declares that an emergency exists justifying such a waiver. No such emergency has yet occurred.

The Cargo Preference Act of 1954 is far more inclusive than the other two preference laws and in fact overlaps them. For example, supplies shipped by sea for the U.S. armed services are subject to the Cargo Preference Act of 1954, as well as to the Military Transportation Act of 1904. Although the earlier act requires that all military supplies must be shipped aboard U.S. flag vessels, it does not require any part of those shipments to travel aboard privately-owned vessels. The 1904 law would be satisfied even if military cargoes moved exclusively in ships owned by the U.S. government. The Defense Department owns its own fleet of cargo ships, which are operated by the Military Sealift Command of the U.S. Navy. The Maritime Administration holds title to vessels in the National Defense Reserve Fleet. None of these vessels answers the description of a privately-owned U.S. flag commercial vessel. Hence they may carry no more than 50 percent of military cargos or of any other cargos subject to the 1954 Cargo Preference Act.

Cabotage Laws

Approximately 40 percent of the active U.S. flag merchant fleet is engaged in domestic shipping operations and is ineligible for any direct government subsidies. These vessels do, however, receive indirect assistance and in addition are protected by U.S. cabotage laws.

From its original meaning of "navigation along the coast," the word "cabotage" has come to denote as well the widespread practice of reserving the trade along a nation's coast to ships of the national fleet. "Coasting trade" is often used synonymously with cabotage in its first sense, and the laws that reserve the trade to national ships are called "coasting laws" or "cabotage laws." In American usage, coasting trade includes not only commerce along the Atlantic and Pacific coasts but also the intercoastal trade (between the

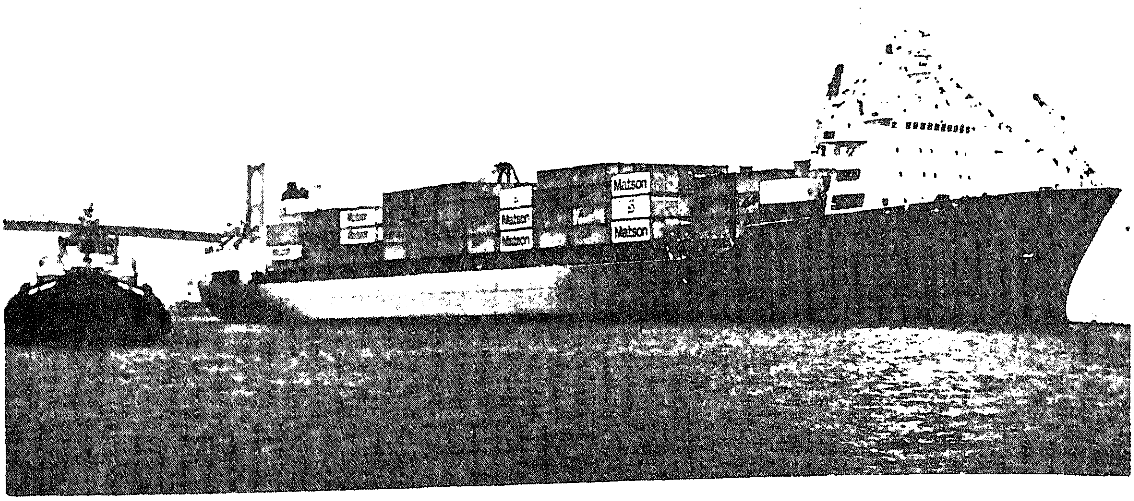

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Figure 3-5.—SS Maui, newest member of Matson fleet, sails down main channel, Port of Los Angeles, outbound on her maiden voyage to the Hawaiian Islands, 26,000-dwt. containership was delivered by Bath (MAINE) Iron Works in May 1978.

two coasts) and trade between the mainland and Alaska, Hawaii, Puerto Rico, and U.S. territories and possessions (fig. 3-5).

For centuries international law has recognized the sovereign right of every nation to reserve its coasting trade to nationals, and many maritime nations have exercised this right. Cabotage is one of the oldest forms of public assistance to national maritime industries, as well as the most common one among nations. It is the oldest extant form in the United States and for most of the nation's history was the most important one also. Today its importance has lessened. The decline of the domestic trades in the postwar period has diminished the advantage the maritime industries gain from cabotage compared with what they receive in other forms of government assistance.

With few exceptions, limited in time and usually to particular trades, the United States has barred foreign ships from participating in the U.S. coasting trade since the federal government was founded. At first they were excluded through a system of discriminatory tonnage duties. Foreign-built and foreign-owned vessels were taxed 50 cents a ton each time they entered a U.S. port, but vessels built in the United States and belonging to its citizens were charged only 6 cents a ton. Furthermore a U.S. vessel, if engaged in the coasting trade, paid duty just once a year. In 1817 this method of exclusion was supplanted by an express prohibition on the movement of goods between U.S. ports in foreign vessels. An exception allowed such vessels to sail from port to port to unload goods transported from abroad and load goods bound for foreign ports. This statute was the nation's first true cabotage law, and its substance is still preserved in the laws today.

Each maritime accretion to the territory of the United States during the country's expansion was followed by an extension of the coasting laws. After the United States acquired territory on the Pacific coast, the intercoastal trade was reserved to U.S. vessels, marking not only a geographical extension of cabotage but something of an extension in its meaning as well. Soon after the purchase of Alaska, Congress decreed that trade with the new territory should be regulated by the coasting laws. Similar action was taken after the United States annexed Hawaii in 1898 and accepted the cession of Guam, the Philippine Islands, and Puerto Rico from Spain in 1899.

The cabotage laws of the United States, both past and present, have always reserved the coasting trade to vessels not only documented under U.S. laws but also built in the United States. Originally the first reservation implied the second. Between 1789 (when the first registry law was passed) and 1912, the privilige of U.S. registry was reserved to vessels of domestic construction.

The Panama Canal Act of 1912 extended this privilege to foreign-built vessels, but only as long as they engaged in the foreign trades. Foreign-built vessels were expressly prohibited from engaging in the coasting trade. This provision has never been repealed and remains a part of the U.S. cabotage laws today.

The cabotage laws were briefly suspended following American entrance into the First World War. With every available ship needed to transport men and supplies across the Atlantic, the U.S. domestic fleet was pressed into wartime service. Congress provided that its place might be taken by foreign vessels, which would be privileged to engage in all the coasting trades except that with Alaska. The suspension was limited to the duration of the war plus 120 days.

Before the period was up, the suspension was lifted and the coasting trades were once more reserved to U.S. vessels. Section 27 of the Merchant Marine Act of 1920, which restored the cabotage laws, is familiarly known as the Jones Act. This is a name that has gained currency as a synonym for all the cabotage laws.

The current cabotage laws of the United States are scattered about Title 46 of the U.S. Code. The most explicit reservation of the trade to vessels built in the United States and documented under the U.S. flag derives from the Merchant Marine Act of 1920. The reservation of the trade to vessels of domestic construction is repeated elsewhere in the title. A third section extends the coasting laws to the nation's territories and possessions.

Another section reserves the transport of passengers between ports of the United States to U.S. vessels. This section has been held to be no bar to voyages on foreign vessels that begin and end at the same U.S. port; hence U.S. vessels have no monopoly of the cruising trade. The most recent addition of significance to the cabotage laws is a ban on the landing by foreign vessels of their catch of fish in U.S. ports. Foreign-built dredges are forbidden to dredge in U.S. waters, unless documented as U.S. vessels. Foreign tugs may not tow U.S. vessels nor may foreign salvors engage in salvaging operations in U.S. waters.

SUMMARY

Despite governmental assistance, the U.S. Merchant Marine has not maintained its relative position among the merchant fleets of the world. The challenge which now faces the American maritime industry is to reverse this declining trend by capturing an ever increasing amount of the expanding oceanborne import/export trade. If this is accomplished, the strong merchant marine fleet which would result could make a vital contribution to this nation's economic security, as we have seen in this chapter. A vital contribution would also be made to the national defense, which is discussed in the next chapter.

CHAPTER 4

THE MERCHANT MARINE/NAVY PARTNERSHIP

The partnership between the merchant marine and the Navy extends back to the birth of our nation when the Navy consisted of armed merchantmen whose crews had learned their profession as merchant sailors. Although every major piece of maritime legislation in this century has emphasized the importance of the merchant marine, it is best stated by Section 101 of the Merchant Marine Act of 1936:

> It is necessary for the national defense and development of its foreign and domestic commerce that the United States shall have a merchant marine (a) sufficient to carry out its domestic water-borne commerce and a substantial portion of the water-borne export and import foreign commerce of the United States and to provide shipping service essential for maintaining the flow of such domestic and foreign water-borne commerce at all times, (b) capable of serving as a Naval and military auxiliary in time of war or national emergency, (c) owned and operated under the United States flag by citizens of the United States insofar as practicable, (d) comprised of the best equipped, safest, and most suitable types of vessels, constructed in the United States and manned with a trained and efficient citizen personnel, and (e) supplemented by efficient facilities for shipbuilding and ship repair. It is hereby declared to be the policy of the United States to foster the development of such a Merchant Marine.

The critical nature of this special relationship was demonstrated during the Falkland Island crisis. Approximately half of the British ships involved in the operation were merchant vessels. Even in the modern world, military forces cannot fight overseas wars without significant shipping support.

SOURCES FOR MERCHANT SHIPPING

In wartime or a national emergency short of war, the government has several sources from which needed ships can be obtained to accomplish one or more of the tasks for which merchants are uniquely suited. These sources include the Military Sealift Command, active U.S. flag merchant ships, the National Defense Reserve Fleet, and foreign flag ships.

MILITARY SEALIFT COMMAND

The Military Sealift Command (MSC), formerly the Military Sea Transportation Service, was established in 1949 by combining the sealift missions of the Naval and Army Transport Services. Today MSC is an operating agency within the Department of Defense (DOD). The DOD fleet commander is the executive agent of the Secretary of the Navy, who in turn is the single manager of all DOD sealift. MSC's primary mission is to support the sealift requirements of all of the military services in the event of war or a nonmobilization contingency. MSC also must plan for the expansion of peacetime shipping capabilities in an emergency. Additional missions include the worldwide direction of DOD cargos by sea in peacetime and the operation of DOD vessels used primarily for nontransportation purposes, such as research ships (including oceanographic survey vessels and vessels used

in support of the NASA space program). More recently, MSC has taken over from the Navy increased responsibility for manning and operating various underway replenishment ships. (See fig. 4-1.)

Military Sealift Command worldwide operations are financed through the Navy Industrial Fund (NIF). The NIF is a revolving fund established to provide working capital for industrial or commercial type activities of the Navy, which provide goods or services to agencies of the Department of Defense. The NIF is not dependent upon Congressional appropriations since MSC charges its customers for services provided in a manner comparable to private business. The primary difference between a government industrial fund and a commercial business is that the objective of the government fund is to break even rather than to return a profit. Revenues from MSC operations during the 1977 fiscal year totaled $758 million. About 80 percent of that revenue was used to purchase commercial sealift services, and the balance funded the operation of the controlled fleet of 105 ships. (See table 4-1).

These ships fall into two general categories, the nucleus fleet and privately owned ships under charter by MSC. The nucleus fleet is comprised of government owned ships and bareboat chartered tankers. All of these ships are known as United States Naval Ships (USNS). Fifty nucleus fleet ships are manned by civilian mariners who have civil service status. They enjoy the normal benefits of federal employees, but their pay and work rules stem from those of the commercial maritime industry. The remainder of the nucleus fleet (18 tankers) are operated by private contractors and manned with union crews. The bulk of the nucleus fleet is made up of special project ships and those involved in direct support of the Navy fleet.

Table 4-1.—MSC Controlled Fleet as of February 1978

	Nucleus	Chartered	Total
Dry Cargo	6	26	32
Tankers	21*	9	30
Fleet Support	17	—	17
Special Projects	24	2	26
Totals	68	37	105

*Includes 14 Bareboat Chartered/Contract Operated Tankers

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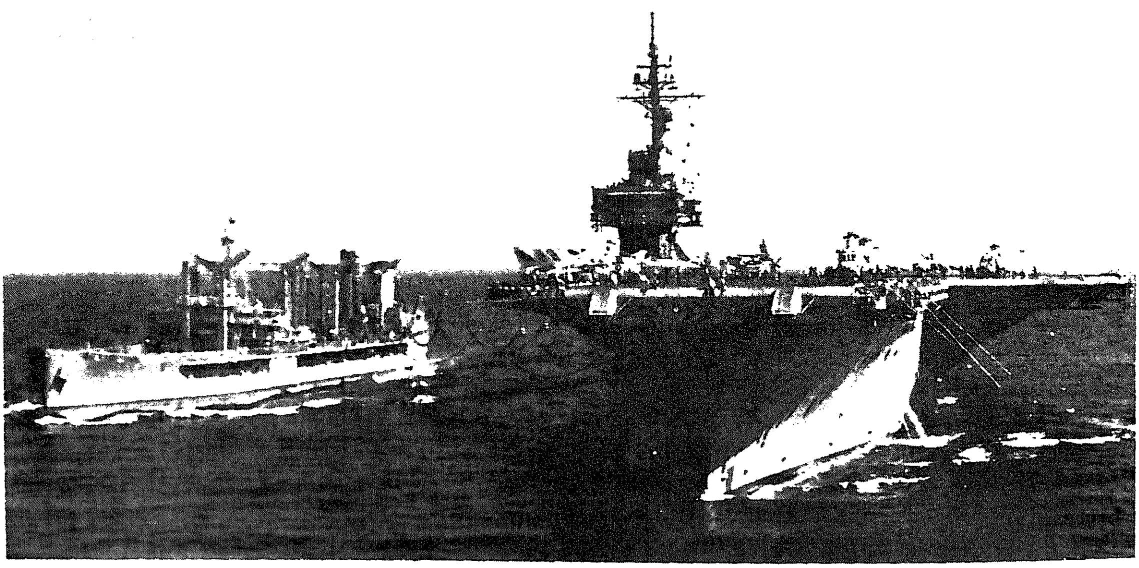

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Figure 4-1.—Civilian Manned MSC oiler refuels a Navy ship.

The major element of MSC dry cargo capability is represented by the 26 vessels of the chartered fleet. Tankers in the chartered fleet are generally under some type of voyage charter, although time charters are occasionally used. All chartered ships are manned and operated by their owners with union seamen. This segment of MSC's fleet will vary in size depending on current requirements.

The ships of the controlled fleet go when and where they are needed to support our armed forces. On any given day these ships may be operating in both polar regions, sailing to and from Alaskan military bases, or delivering cargo for military units in Europe and the Far East. In peacetime and during war, MSC's fleet is the immediately responsive contingency sealift force needed to support national military, economic, and diplomatic policies.

U.S. FLAG MERCHANT SHIPS

In peacetime, MSC relies heavily on the U.S. merchant marine, shipping nearly 95 percent of all military cargo on privately owned U.S. flag ships, with 64 percent of all cargo moving on scheduled cargo liners. It is obvious, given the small size of the controlled fleet, that MSC must plan to augment its available sealift force with additional merchant ships during an armed conflict involving the United States.

U.S. flag ships would be requisitioned by the National Shipping Authority (NSA) to meet the demands of major war. The greater part of the U.S. liner fleet would be required for support of military operations in major war. Diversion of a large part of the U.S. general cargo fleet to military employment would require controlled use of remaining capacity for essential civil purposes. To meet national needs on a basis equitable to all ship owners, operators and shippers, NSA would take the entire U.S. flag foreign trading general cargo fleet under control. This would also include any tankers and bulk carriers necessary for military operations.

Ships particularly suited to military support service would be requisitioned from domestic and domestic offshore trades. Otherwise, those trades would continue on as near a normal footing as circumstances permitted under NSA emergency regulations.

Tankers and dry bulk carriers operating in regular services in support of national war production and supply programs might be continued in their accustomed operations without requisitioning under NSA emergency regulations.

Generally, military support requirements for small contingencies, beyond the capacity of the NDRF, would be met by chartering. However, in small-scale military contingencies, a few ships might be requisitioned to meet specific military support requirements.

U.S. OWNED, FOREIGN REGISTERED SHIPS

The United States has authority under the Merchant Marine Act of 1936, to requisition foreign-registered ships owned by U.S. citizens or U.S. citizen corporations. The desirability of requisitioning will depend upon the circumstances in each case.

U.S. owned, foreign registered ships consist chiefly of tankers and dry bulk carriers, which are integrated into the industrial operations of their owners. Although some of the ships trade foreign-to-foreign, such cross-trading is, in general, an aspect of the multinational operations of the U.S. based industrial corporations which own the ships. So long as ships in civil trade remained responsive to their U.S. owners in execution of U.S. priority programs and conform with U.S. wartime economic and other policies, it might be preferable to continue their operations under their peacetime registries. However, the NSA would need to have full knowledge of the employment of U.S. owned ships during periods when U.S. flag ships are requisitioned. In a NATO war, U.S. owned flag of convenience ships might be requisitioned if allied countries requisitioned flag of convenience ships owned by their nationals.

When U.S. owned ships registered in foreign countries were not responsive to U.S. direction or when other circumstances warranted, the NSA would requisition the ships, require their owners to reregister them under the American flag, and direct their operation on the same basis as other requisitioned U.S. flag ships.

NEUTRAL SHIPS

The United States might exercise the right of angary, as reflected in the provisions of the Emergency Foreign Vessels Acquisition Act, to requisition neutral ships in U.S. waters. Preservation of the right is important in principle, but the right would be exercised only in rare cases and is unlikely to be significant in practice.

SHIPS AVAILABLE UNDER VOLUNTARY AGREEMENTS AND CONTRACTUAL COMMITMENTS

Whenever the requisitioning of ships under the Merchant Marine Act of 1936 is authorized, the Maritime Administrator may negotiate the use of vessels owned by citizens of the United States on a voluntary bareboat or time charter basis, without requisitioning. The purpose of this authority is to acquire the use of privately owned vessels quickly in emergency. If the owner of a vessel is willing to agree voluntarily to make his ship available to the government on terms satisfactory to both parties, there is no need to go through the formalities of requisitioning.

VOLUNTARY ACQUISITION OF FOREIGN VESSELS BY THE NSA

Under the provisions of the Emergency Foreign Vessels Acquisition Act, during any period in which vessels may be requisitioned under U.S. laws, vessels not owned by citizens of the United States may be purchased or chartered by voluntary agreement. Such vessels may be documented as vessels of the United States, at the discretion of the Secretary of the Treasury, and may engage in U.S. coastwise trade upon the granting of permits by the Secretary of the Treasury.

VOLUNTARY TANKER PLAN

The Voluntary Plan Under Public Law 774, 81st Congress, as amended, is for the Contribution of Tanker Capacity for National Defense Requirements (Voluntary Tanker Plan). It sets up a procedure under which the owners and charterers of oil tankers agree voluntarily to make tankers and tanker space available to the Department of Defense. It also includes other participants in the plan (that is, other tanker owners who may not have free capacity with which to meet their obligations under the plan) in emergencies involving military security. The plan is important for military contingencies other than NATO war.

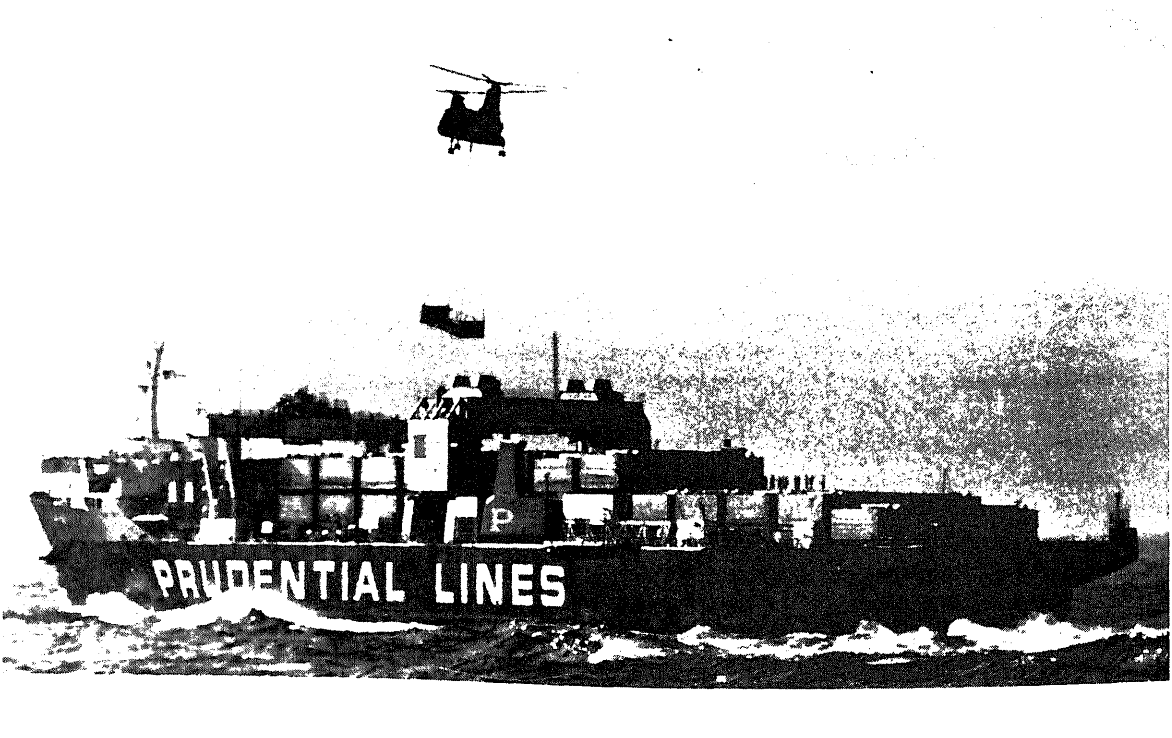

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Figure 4-2.—A helicopter transfers supplies from a U.S. Flag Merchant Ship to a Navy supply ship (not shown).

SEALIFT READINESS PLAN

Under the Sealift Readiness Plan, ship operators participating in Military Sealift Command shipping agreements and container agreements make available half of their ships to the Department of Defense, without requisitioning, when requested by the Secretary of Defense with the concurrence of the Secretary of Commerce. Under the provisions of P.L. 95-298, ships for which Operating Differential Subsidy or Construction Differential Subsidy is paid from FY 1979 appropriations must be offered for participation in the Sealift Readiness Plan. The list of ships designated as available to the DOD under the plan is maintained by the Military Sealift Command. The plan is applicable to short notice surge requirements, under conditions which do not warrant the requisitioning of ships; that is when it is expected that the need will be brief or that NDRF ships will be activated to replace SRP ships withdrawn from trade so that the commercial vessels may return to trade.

Ships called up under the program would be chartered by MSC and under operational control of the Navy command. (See figure 4-2). Charter rates would be in accord with those prevailing in the world shipping market at the time.

OTHER SHIPPING RESOURCES

Allied Ships

In NATO war, member countries would enter their ships in a common pool, from which they would be allocated to users in the overall best interests of the Alliance. Foreign flag ships provided the United States from that pool would be regarded, from the U.S. NSA viewpoint, as chartered by the United States under the voluntary chartering provisions of the Emergency Foreign Vessels Acquisition Act.

Other Ships in U.S. Trade

Allied ships would transport U.S. goods bought in the U.S. for allied government account. Neutral ships would provide carriage in neutral trades from U.S. ports. The employment of these ships would be governed by U.S. military assistance and trade policies and programs, wartime export/import control procedures, and U.S. wartime resource management programs. The availability of these ships in U.S. trade would affect requirements for and employment of ships controlled by the NSA, and the NSA therefore would maintain cognizance of their activities.

National Defense Reserve Fleet

The Maritime Administration maintains the National Defense Reserve Fleet (NDRF) as a ready source of merchant ships to support military operations, if the need arises. NDRF vessels are also available for use in nonmilitary emergencies, such as commercial shipping crises.

The NDRF was established by the Merchant Ship Sales Act of 1946, which was passed to dispose of the more than 5,000 government owned merchant ships built during World War II. Those ships needed for national defense or not sold were placed in reserve. The size of the reserve fleet peaked at more than 2200 ships in 1950, but it has been declining ever since.

Reserve ships have been used several times in the postwar period. Five hundred-forty vessels were broken out during the Korean War to support the active merchant fleet. In 1956, approximately 200 cargo ships and 30 tankers were activated when the closing of the Suez Canal caused a severe worldwide shipping shortage. NDRF ships were also used between 1953 and 1963 to store over 150 million bushels of surplus wheat. The most recent callup of the government's reserve ships was in connection with the Vietnam War. From 1965 to 1970, 172 ships were withdrawn and, as in the past, were operated by private firms under general agency agreement contracts with MSC. These ships carried approximately 30 percent of all government cargo to Vietnam during their period of service.

Today, the NDRF consists primarily of World War II Victory-class ships and naval auxiliary vessels. They are anchored at James River, Virginia; Beaumont, Texas, and Suisun Bay,

California. As of July, 1983, there were 263 ships moored at the three locations (see table 4-2).

As part of a joint project with the Navy, MARAD began in 1977 to upgrade selected ships of the NDRF to Ready Reserve Fleet (RRF) status. The RRF goal is to provide the Department of Defense with a sealift capability of approximately 340,000 measurement tons, with the ships capable of activation within 5 to 10 days for deployment during national emergencies. (See fig. 4-3.) Activation tests are carried out in the RRF periodically with no advance warning to ensure this capability.

The first increment of ships assigned to the RRF consisted of the youngest ships available in the NDRF. This included five C-3 breakbulk ships constructed in 1960-1961, several of the SEATRAIN series ships (mostly former T-2 tankers which had been converted to intermodal carriers), and three MARINER class breakbulk ships built during the early 1950's.

The Ready Reserve Fleet, as was noted earlier, provides the only surge shipping capacity available to meet military contingency requirements without withdrawing commercial ships from trade.

MILITARY USE OF MERCHANT SHIPS

The previous chapter discussed the diversification of the U.S. flag fleet (table 3-1) and also indicated the continuing substitution of intermodal carriers for the less efficient breakbulk freighters. Both of these trends have important implications for military contingency planners that are relying on the U.S. merchant marine to support military operations in wartime.

Breakbulk Ships

Of all the various ship types in the American fleet, the breakbulk vessel, capable of accepting outsize military cargo, such as tanks, and discharging its own cargo in unsophisticated ports, is the most desirable to the Department of Defense. As these ships have grown older and are increasingly replaced by intermodal ships, defense sealift plans have been changed.

Ro-Ros

Among the intermodal vessels, the Roll On/Roll Off (Ro-Ro) ships are prized for their ability to carry large numbers of wheeled and tracked vehicles and ease of loading and discharge. Some of the Ro-Ros can carry helicopters on their weather deck, as well as being able to accommodate outsize cargo and containers. With minor modifications, the Ro-Ro could be adapted to replenish Navy auxiliary ships in a direct support role.

Barge Ships

The barge ships (LASH and SEABEE) have also demonstrated a special capability for

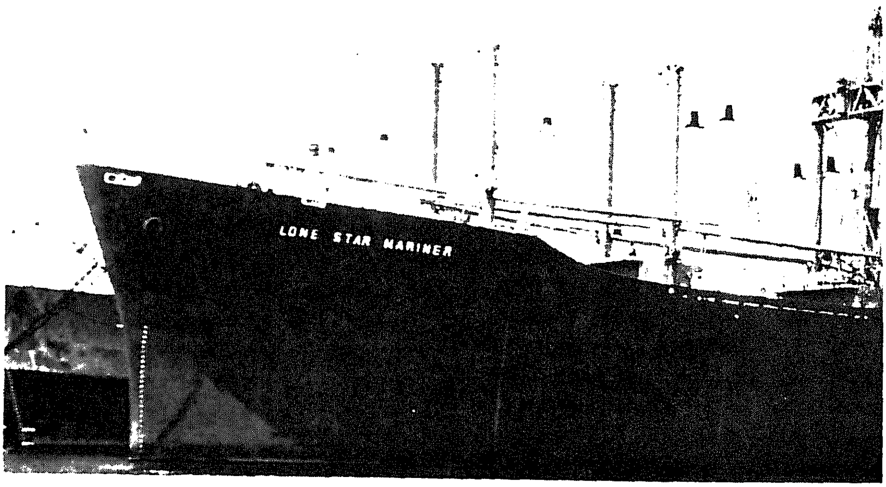

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Figure 4-3.—National Defense Reserve Fleet

Table 4-2.—NDRF Reserve Fleet Summary

NDRF
RESERVE FLEET SUMMARY

		TOTAL	JAS	MOB	BEAU	SUI
1 TRANSPORTS & PASSENGER CARGO						
AP	-P2	7	2			5
AP	-P2E	6	4			2
		13	6			7
2 MILITARY AUXILIARIES						
AE		1	1			
AE	-C2A	1	1			
AF	-C2	2	2			
AG		1				1
AG	-C41A	1	1			
AGM	-C4SA	1	1			
AGR	-ZEC5	1	1			
AH	-C482	1	1			
AK	-C2	1				1
AK	-C4	1	1			
AK	-V*2	1	1			
AK	-V*3	1	1			
AKC	-C1ME	1	1			
LKA	-C2	5	5			
LKA	-C2A3	2	2			
LKA	-C2F	1	1			
LKA	-C41A	1				1
LPA	-V*5	27	27			
LST		6				6
		56	47			9
3 TANKERS						
AO		2			1	1
AO	-ST2E	1				1
AO	-T2A	1				1
AO	-T2E	5	3		2	
AO	-T352	1				1
AO	-T352	3	3			
AO	-XT2E	1			1	
		14	6		4	4
4 DRY CARGO						
AK		6	4			2
AK	-C333	4	3		1	
AK	-C338	4	4			
AK	-C346	1	1			
AK	-C41A	1	1			
AK	-C41H	2	2			
AK	-C41P	2	1		1	
AK	-C41Q	2				2
AK	-C41U	2			1	1
AK	-C457	3			3	
AK	-C458	5	5			
AK	-C573	3	3			
AK	-C60C	2				2
AK	-V*2	112	38		19	55
AK	-V*3	18	8		6	4
AK	-XST2	9	7		2	
AKC	-N3M	1	1			
AKR		1	1			
AKR	-C578	2	2			
		180	81		33	66
TOTAL SHIPS		263	140		37	86

Fleet Sites

JAS	James River Virginia	BEAU	Beaumont Sabine River Texas
MOB	Mobile Bay Alabama	SUI	Suisan Bay California

handling vehicles, particularly tanks. Fortunately the equipment needed to unload their barges is readily available in sea and river ports. Helicopters can be carried below decks, protected from the weather in near fly-away condition. In one test, a SEABEE barge was delivered to Mannheim, Germany where the helos were lifted out of the barge by a large crane and set down adjacent to the wharf. Rotor blades were affixed and the helos flew away. In addition, barge ships are useful for the heavy lift of engineer equipment, harbor craft, and locomotives.

Containerships

The containerships have challenged military planners to develop innovative methods of adapting this ship type to military uses. In general, containerships are best suited for the follow-on resupply phase of a military operation. Several imaginative proposals, which have emerged for taking advantage of the large numbers of containerships in the U.S. and NATO commercial fleets, will be discussed in this chapter.

Tankers

For military purposes tankers of less than 40,000 dwt are generally more useful than larger tankers. Tankers in excess of 40,000 dwt are more susceptible to certain influence mines with coarse settings, and they lack the maneuverability and versatility provided by equal capacity in several smaller ships. Tankers between 40,000 and 100,000 dwt have value in moving large quantities of fuel between ports that can accommodate them, in the consolidation of petroleum products to a naval replenishment ship, and as floating storage sites in low vulnerability areas. Tankers larger than 100,000 dwt have displacements of such magnitude that their resulting lack of maneuverability, deep draft, and size make it unlikely that they would be used directly in military operations. In the larger context of national security, however, such tankers (including LNG/LPG ships) are needed to supply the energy demands of the economy.

Tankers of less than 40,000 dwt have a great potential for use as naval auxiliaries both for general liquid cargo transportation and operating with naval units at sea. Consequently, for ships built with a construction differential subsidy, provisions are made for future installation of alongside refueling rigs, an astern refueling rig, and a highline transfer station.

NATIONAL DEFENSE FEATURES

The present-day relationships of our merchant marine and Navy originate from the requirement for the merchant marine to be "capable of serving as a naval and military auxiliary in time of war or national emergency." To fulfill this requirement there must be close cooperation between the Maritime Administration (MARAD) and the Department of the Navy concerning national defense needs and the adaptation of the merchant fleet to meet national defense requirements.

One such program involved the incorporation of national defense features on ships built under the recently discontinued Construction Differential Subsidy (CDS) Program. Under this program, established by the 1936 Act, the Secretary of the Navy was required to examine the plans and specifications of a proposed vessel; the Secretary would then suggest such changes as may be deemed necessary, and certify that the ship is suitable for economical and speedy conversion into a naval or military auxiliary, or otherwise suitable for use by the United States government in time of war or national emergency.

Basic Standards

Despite the wide variety of ship types and military missions, certain basic NDF standards were sought on all ships built with the aid of CDS.

1. Compartmentation to be provided that will, as a minimum, ensure the ship's survival in the event of the flooding of any single compartment.

2. Cargo ships having the potential for use as a naval or military auxiliary would have a minimum sustained speed of 20 knots, with a goal of 25 knots. The desired maximum speed of tankers is 20 knots. Such speeds are generally not economically feasible in commercial tanker operations. For this reason, a lower limit of approximately 16 knots is acceptable providing that the proposed tanker can maintain a sustained

speed of 15 knots, while pumping two products at a minimum of 3000 gpm each with ensured separation.

3. Resistance to damage by shock stresses is provided by the general exclusion of cast iron mountings in equipment and systems, which affect the survival capability of the vessel.

4. The generating plant capacity be increased, or space and weight reservations be made for future installation of additional generating units to meet such contingencies as reefer containers, habitability modules, or self-defense systems.

5. Distillation and feed/potable tankage capacity be based on naval criteria to provide for military personnel and for the fresh-water washdown of embarked operational helicopters.

6. Water washdown systems be provided to enhance the passive defense of merchant ships against nuclear, biological, and chemical (NBC) attack. The washdown system consists of clips and brackets for attaching standard fire hose nozzles in countermeasure washdown position for each weatherdeck fire station. The clips and brackets are located so that the greatest spray coverage is obtained for all topside areas. Provisions are also made for the installation of radiological monitoring equipment.

Additional features may be considered for those designs having potential to carry out certain military support functions. Ships required for essential economic support of the nation in time of war or national emergency, to transport fuel, raw materials, and other supplies, would not be expected to participate in the direct military support role. Ships dedicated to these operations, will have NDFs designed to ensure maximum survivability.

MERCHANT SHIPS IN MILITARY OPERATIONS

The conversion of commercially viable merchant ships into efficient and useful military auxiliaries is not without its difficulties. Whether the merchant is to be used in logistic resupply, direct support of naval forces or as an auxiliary combatant, creative solutions are needed for the conversion problems.

Logistic Resupply

Merchant ships employed in the logistic resupply of military forces must be able to operate in a difficult shore environment. In situations where the port unloading facilities and the inland transportation system cannot handle a high volume of traffic, barge and Ro-Ro ships have an advantage.

The LASH and SEABEE ships can easily anchor in a port or close offshore and discharge their barges without any assistance. The barges can then be transported upstream toward the ultimate destination as long as tugs are available.

The Ro-Ro ships require only simple ramp facilities at pierside to discharge their cargo. Alternatively, the Navy is studying a concept whereby portable ramps could be installed to allow offloading of vehicles to a barge or lighter with the ship at anchor in the open stream. (See figure 4-4.)

The breakbulk ship, as long as it remains available, is able to offload its cargo at an undeveloped pier area or into a barge or lighter while anchored out. Self-sustaining containerships

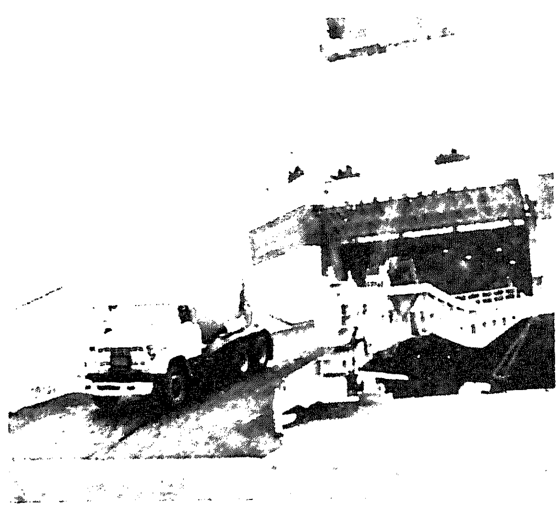

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Figure 4-4.—Ro-Ro Ship Offloading.

ıre also useful for resupply operations to less ieveloped parts of the world.

Military contingency planning, however, must ake into account the trend of the past 15 years n commercial shipping towards fast, non-self- ıustaining containerships. In 1979 there were 105 :ontainerships in the U.S. flag fleet of which 90 vere non-self-sustaining. Containerization epresents a significant advance in dry cargo)perations, but these advantages cannot be ealized without a modern containerport, which s unlikely to be available when and where it is ıeeded.

To use this significant portion of the U.S. ealift capacity, construction of conventional ›orts, conversion of non-self-sustaining container- hips to self sustaining by the addition of gantry ranes on rails and container discharge by .elicopter have all been studied by the Depart- ıent of Defense. All of these alternatives have ·een rejected because they are either too time onsuming, too costly, or both. The approach to .nloading non-self-sustaining containerships .nder development by the Navy is essentially imed along two parallel paths:

1. The use of mobile Cranes-On-Deck (COD) nd hatch cover crossing and load transfer bridge nits to provide a self-sustaining capability for ontainerships.

2. Temporary Container Discharge Facilities ГCDF) conceived as cranes on ships or barges.

In the COD concept, when a contingency :quiring self-sustaining ships arises, mobile :anes, previously identified in the commercial :ctor, are placed on the ships before sailing from ıe United States. The use of relocatable hatch)ver reinforcing and bridging mat assembly will .low the mobile crane to transfer its wheel and utrigger load from the hatch covers to the ship's rimary structure and to cross from one hatch)ver to another. Two or three cranes would be :aced on each ship depending upon the specific)nfiguration of the ship. (See figure 4-5.) For ıch crane placed on a containership, about 50 wenty foot Equivalent Unit (TEU) containers ·e displaced. Thus 2 to 3 cranes would result in 10 to 15 percent cargo loss for a 1,000)ntainership, but it would be able to offload its ırgo to a simpler pier or lighters without any sistance.

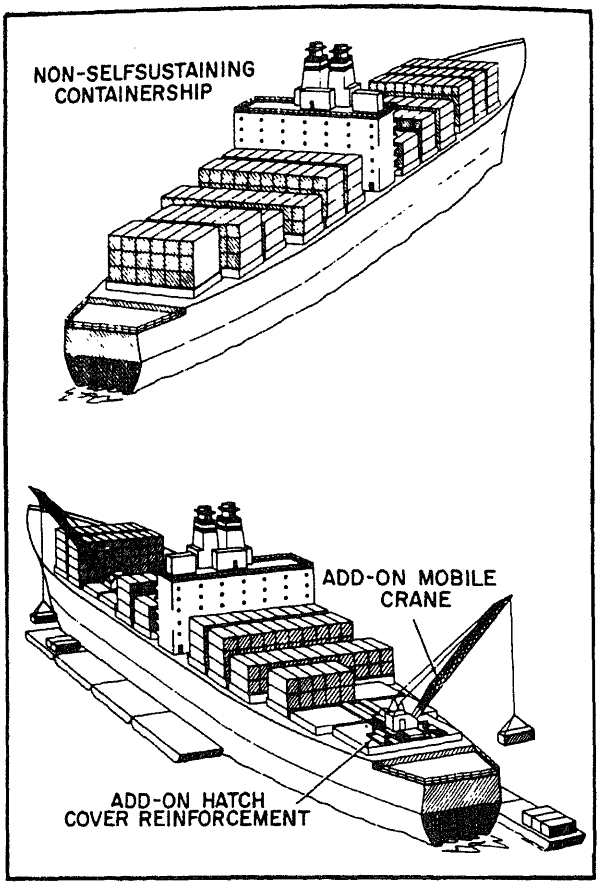

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Figure 4-5.—Conceptualization of COD Operation.

Among the disadvantages to this idea is that the cranes experience considerable transit time at sea, increasing the probability of water damage. In addition, upwards of 270 mobile cranes of 150-200 ton nominal capacity would be required for the entire population of the U.S. flag non-self-sustaining containerships.

Substantially fewer cranes would be needed for the TCDF approach. The TCDF cranes, however, will be in a state of continuous offshore use for several weeks and even months, which would expose them to structural or mechanical fatigue type failures. The COD cranes, on the other hand, see only intermittent use with the opportunity for servicing and replacement in the United States after each trip, if needed.

Tankers or other types of bulk carriers are the most likely candidates for self-propelled TCDFs.

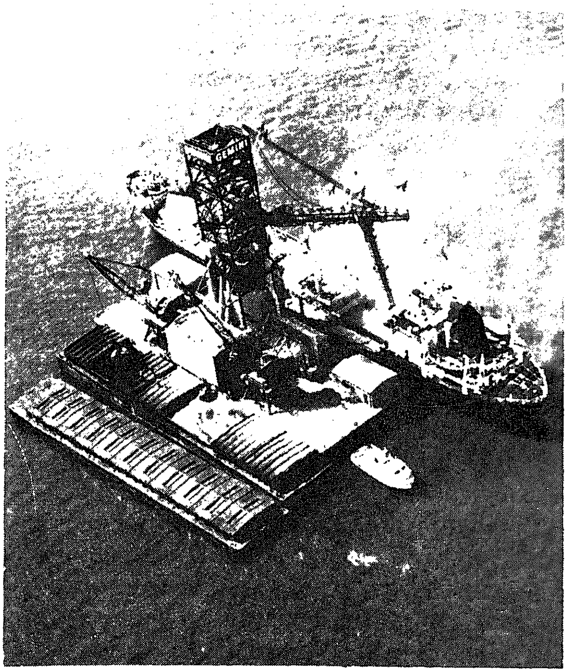

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Figure 4-6.—Temporary Container Discharge Facility (TCDF).

(See figure 4-6.) Similarly, Army DeLong Type B barges are a possibility for non-self-propelled platforms because of their existence and apparent transportability on SEABEE class ships.

When a TCDF is needed, a suitable platform would be identified, and then prefabricated foundations and cranes would be installed in a few days. The ship or barge would then deploy to where it is needed. Containerships would berth alongside the TCDF in a protected anchorage, and the cargo could be offloaded to lighters or a pier.

Depending on total sealift requirements, studies indicate that a mix between the COD and TCDF concepts will achieve an affordable yet responsive capability for most conflict levels. The costs would be reasonable in comparison to any other conceivable alternative available.

Direct Support

The Navy has developed a sophisticated mobile logistics system that extends the range and endurance of combatant ships through Underway Replenishment (UNREP). The Navy today has less than fifty specialized replenishment ships, which include oilers, dry stores ships, ammunition ships, and ships that are combinations of these. Of that number almost half are over 20 years old. Although a new class of oilers is under construction, fiscal constraints and the need for new combatants, have resulted in fewer replacements for the aging oilers and ammunition ships.

At the present time the Navy's UNREP ships are adequate to support sustained combat operations that are relatively close to U.S. controlled bases or to support peacetime operations to remote areas. In the future, however, the Navy may have to deal with the loss of strategically located U.S. controlled bases or the necessity to conduct sustained combat operations in remote areas of the world. In this instance, sea lines of communication are greatly extended and heavier demands are placed on the supply ships which replenish combatants at sea. Without a major increase in construction, there will be fewer of these critical supply assets available when they are needed. In such a situation, the Navy must be able to turn to the merchant fleet for assistance.

The use of merchant tankers for the transfer of fuel at sea to Navy ships is easily accomplished using simple techniques and requiring only minor modifications to the merchant ship as was mentioned before. This evolution is discussed in detail in chapter 6. In a shooting war, the critical need is for large amounts of ammunition to be supplied to the combatants while on station.

Again the logical solution calls for merchant ships to carry the needed quantities of ammunition from safe supply depots for transfer to Navy replenishment ships which would in turn transfer the cargo to the combatants. The missing link in this chain, however, is the ability of merchant ships to transfer dry cargo to Navy ships with the same ease as merchant tankers deliver petroleum products. There have been two proposed solutions to this problem, the first using containerships and the second involving tankers.

Particular attention has been paid to containerships for fleet support because of the large number available and projections by MARAD that containerships will make up 90 percent of the

U.S. dry cargo fleet by 1990. The Navy and MARAD set up a joint research and development program in 1975 known as the Merchant Ship Naval Augmentation Program (MSNAP) to adapt containerships to the direct support role.

The MSNAP approach uses loaded container flats instead of the regular container. (See figure 4-7.) These flats are the same size as containers, but they are open on the sides and top. A single layer of flats in the ship, therefore, becomes a deck, and a container cell filled with layers of flats has decks at every eight feet, with access between. A single container position on each layer is left open, so that a modular cargo elevator can be dropped vertically into the opening and serve all levels for unloading.

Since none of this gear requires fundamental modification to the basic configuration of the ship, any containership can be used. The flats are loaded like conventional containers, and the elevators are lowered into place with dockside gantry or cranes, thereby requiring a minimum of special skills for installation. The ship can then be loaded initially with loaded flats, taking advantage of the speed of containership outload. But, since each deck level can be reached by elevator and forklift, the ship can "strike up" and discharge cargo in smaller loads more suitable for ship-to-ship transfer at sea.

Once it is topside, the pallet is moved by conventional material handling equipment to underway replenishment stations. Special bridging is used between hatchcovers to facilitate the movement to portable UNREP stations, where the cargo is then passed to the Navy ship by conventional UNREP techniques.

To adapt a merchant ship for interface with a Navy UNREP ship requires, as a minimum, an UNREP receiving station. This consists of hardware that provides a strength point above the deck to mate with a corresponding strength point on a Navy replenishment ship which has powered winches for transfer operations. A wire "highline" is passed between the two UNREP

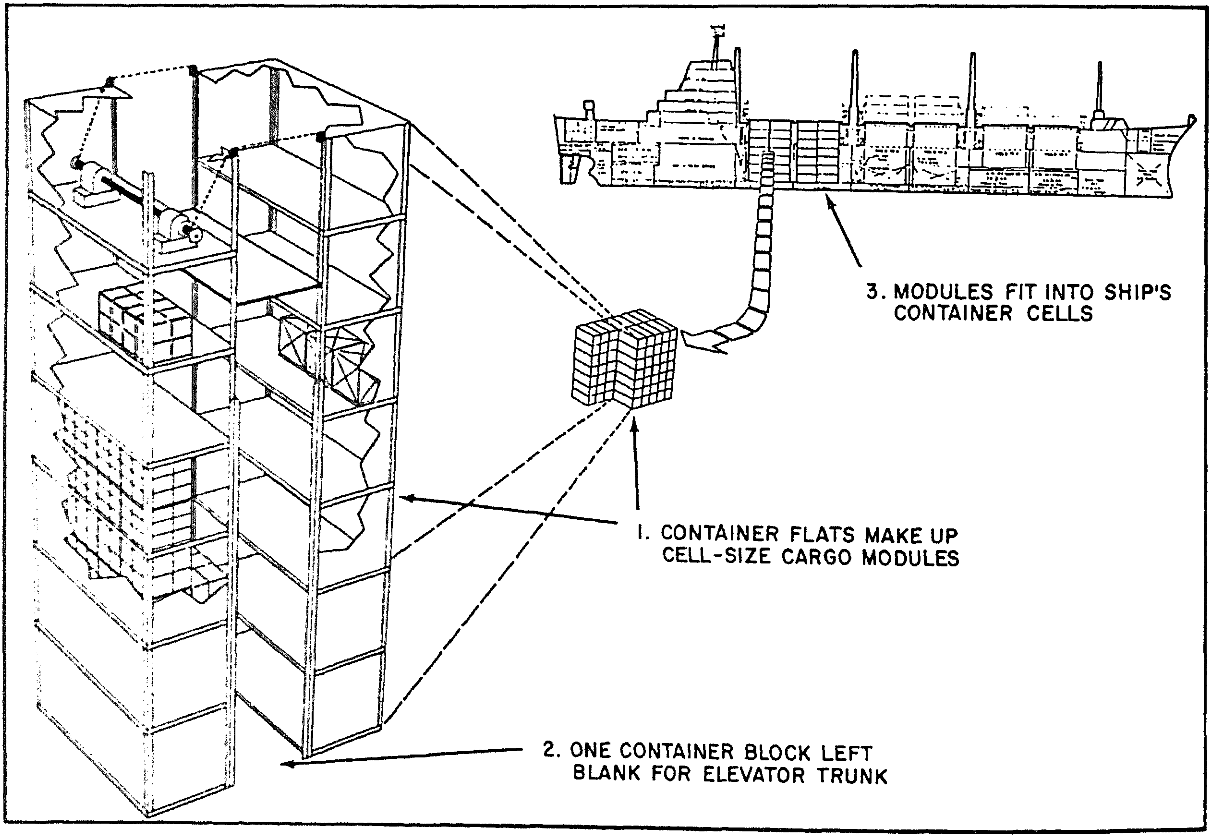

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Figure 4-7.—Container Flats Used to Form Break-Bulk Cargo Holds.

stations and the loads are passed between ships on blocks running along this "highline." The strength point must be high enough to ensure that the load clears the water enroute, but configured so that crews working at deck level can reach the gear to hook up the loads. One method of doing this is to construct a vertical strength member with a sliding padeye. (See figure 4-8.) The padeye can be lowered for hookup of the load, then raised while the load is passed to the other ship.

Since the MSNAP gear is aimed primarily at working with a Navy replenishment ship which has powered winches at its UNREP station, the merchant ship adaptation need only provide the strength point at its end. The figure shows a conceptual design of a portable UNREP station that can be lifted onto the deck of a merchant ship and secured to strong points on its deck.

Conceptual designs are also being developed for universal hatch covers. The hatch cover problem stems from the fact that hatch size and shape varies widely from ship to ship, yet adapting the container cell for unloading through an elevator requires an access in the hatch cover that does not now exist. The task, therefore, is to develop a hatch cover that can be used to replace hatch covers of any of a wide number of different hatches, while providing appropriate access for "striking up" cargo by MSNAP elevator. Only partial answers to this problem have thus far been developed, and it remains one of the more challenging engineering problems of the MSNAP concept.

The other approach to the use of merchant ships to resupply naval ships with ammunition and stores involves modifying merchant tankers, as was done in World War II when a shortage of shipping for moving bulky cargo, such as aircraft and landing vehicles occurred. To meet this need, the MECCANO deck was developed and installed to provide a platform for cargo.

Under an update of this idea, merchant tankers that shuttle fuel out to carrier task forces would be outfitted with a modern version of MECCANO decks that would be used to carry commercial containers loaded with ammunition.

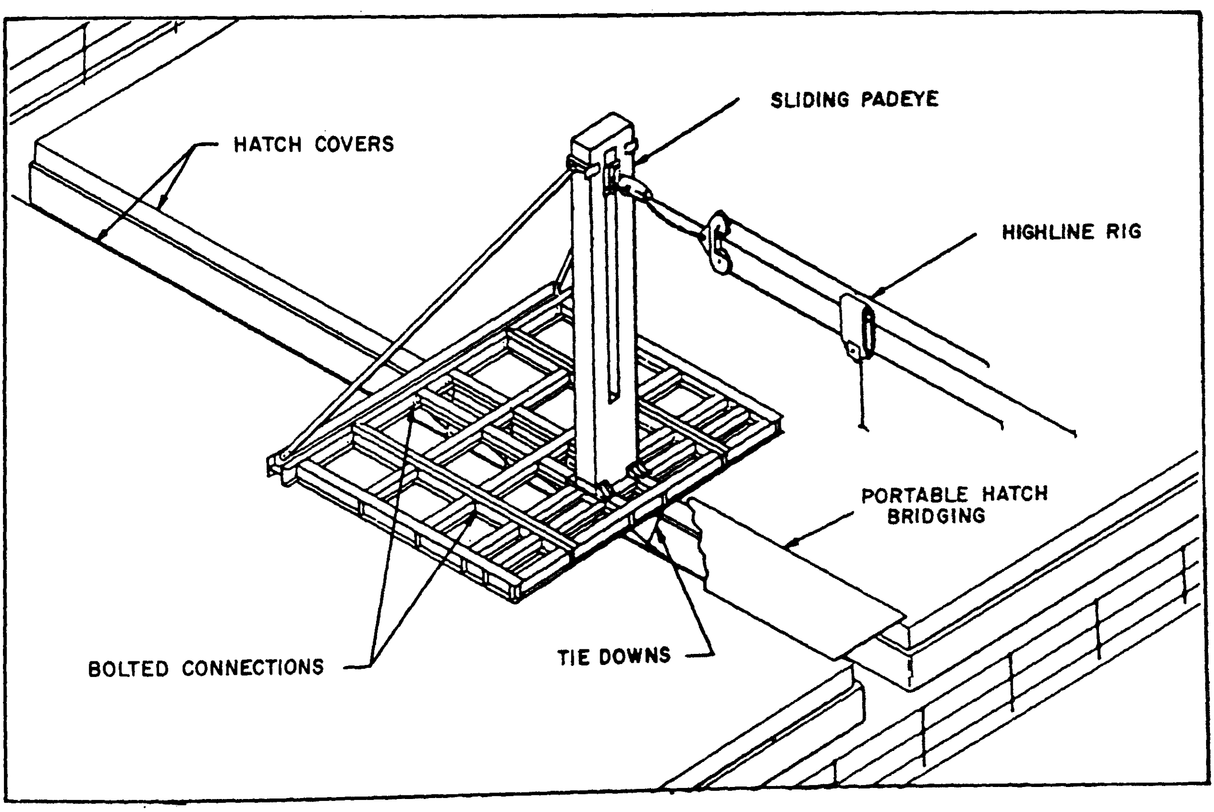

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Figure 4-8.—Portable Highline Rig for Containerships.

(See figure 4-9.) The tankers would have only a single layer of containers so that elevators will not be needed nor will there be problems in unstuffing containers two or more high above deck. Fork trucks operating on the MECCANO deck unstuff palletized ammunition from the containers and move the pallets to the UNREP stations.

UNREP ships would come alongside the tanker and provide the transfer rig. (See figure 4-10.) The merchant ship requires only a sliding padeye arrangement. If needed, Navy personnel can be transferred to assist in handling cargo. The UNREP ship would again direct the cargo where it is needed in the task group.

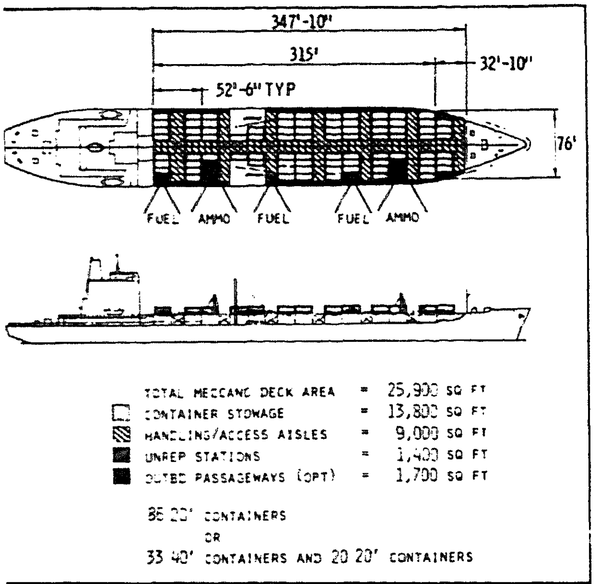

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Figure 4-9.—SEALIFT Class Tanker outfitted as Merchant Shuttle Ship.

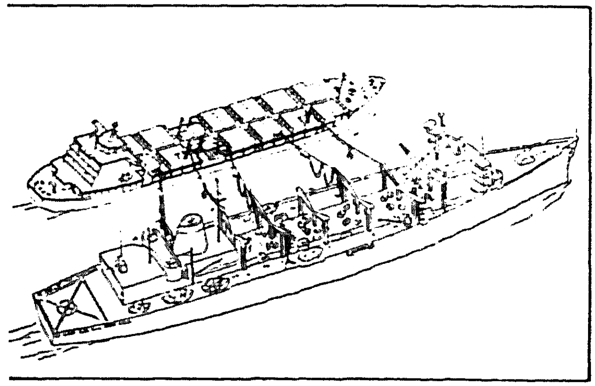

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Figure 4-10.—Navy AOE UNREP Ship consolidating with Merchant Shuttle Ship.

The 25,000 dwt Sealift Class tankers, which were built for charter to MSC, could accommodate eighty-six 20 foot commercial containers. In addition, three fueling at sea and two ammunition/stores UNREP stations would be provided on the starboard side to receive the UNREP ship's transfer rigs in the proposed configuration.

It seems unlikely that the number of Navy UNREP ships will be expanded in the forseeable future. The proposals to adapt containerships and tankers are therefore necessary to extend the range so that existing UNREP ships can provide support to carrier task groups in sustained combat operations.

Auxiliary Combatant

In today's changing naval environment, which includes the declining U.S. Navy fleet size, increasing ship construction costs and time and the increasing capabilities of the Soviet Navy, the traditional methods of developing and maintaining a naval fleet may not be adequate. Alternative approaches must be examined. These include the development of concepts for effectively exploiting the combat potential of commercial merchant ships.

The basic concept of adapting merchant ships to wartime emergency duty is not new. Merchant freighters, liners, and bulk carriers have been pressed into national service for centuries by many countries. The generally accepted presumption has been that the principal combat role of such ships would be thoroughly defensive, retaining logistics delivery as its primary function and employing its weapons only in the event of attack. The armed merchant ship was never intended to pose a serious threat to an adversary.

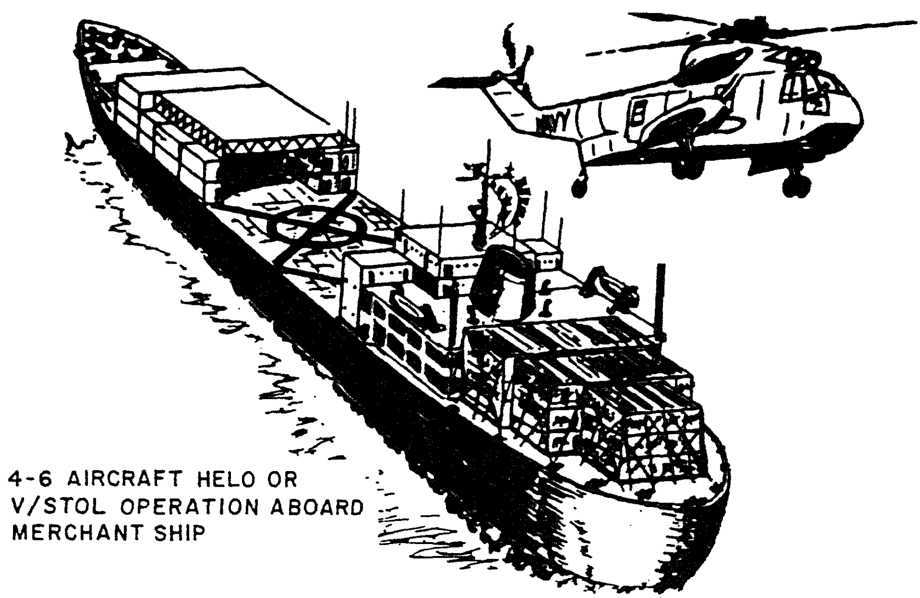
In recent years the introduction of the intermodal ships and the development of new weapons technology have opened up many possibilities for the conversion of merchant vessels into auxiliary combatants. The most promising concept being tested is ARAPAHO, a modular aviation facility that will allow sea-based helicopters to operate from commercial merchant containerships. The primary mission envisioned for ARAPAHO (also known as the Reserve Merchant Ship Defense System—RMSDS) is to protect a merchant ship or convoy from submarine attack. The system provides for the entire helicopter support facility to be fitted in a number of standard (8 × 8 × 8 × 20- or 40-foot) container shapes: the flight deck, hangars, crew quarters, galley fuel, ordnance,

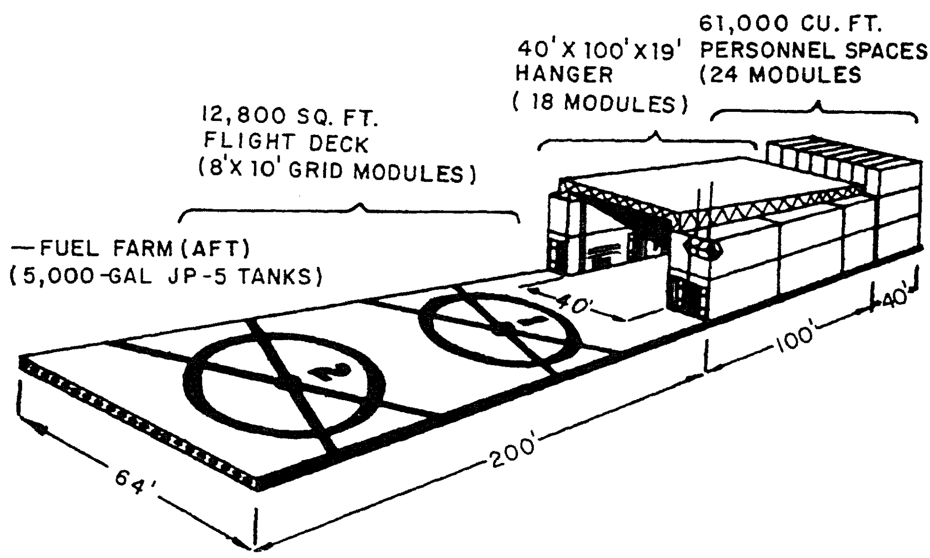
power supply, repair lockers, and even administrative offices. (See figure 4-11.)

The containerized helicopter facility would be installed at the loading port atop several hundred standard, cargo carrying containers. The exact number of filled containers in the ARAPAHO facility would depend upon the size and configuration of the ship to be armed. Once installed, the ARAPAHO facility will support several SH-3 Sea King ASW helicopters. Once at sea, the Sea Kings would prosecute contacts detected from electronic intercepts or other shipboard sensors, or by third-party sensors. Upon arrival at the overseas port the ARAPAHO containers would be removed first, then returned to the original ship after the new cargo was loaded, or attached to another ship. Preliminary design of ARAPAHO has been completed, and at-sea evaluation has been successfully conducted.

The major advantage of APAPAHO over previous concepts of modifying merchant ships to operate aircraft is that the armed ship requires no structual changes. The helicopter facility can be loaded and unloaded as simply, and almost as rapidly, as loading standard cargo containers.

Ideally, the ARAPAHO packages would be prefabricated and situated around the country at Naval Reserve sites for training and maintenance.





For war and exercises, the modules could be shipped by truck, train, barge or aircraft to a containerport and installed on any one of several hundred U.S. or NATO flag containerships. The cost, approximately $10 million per installation, is only a fraction of that required to build and maintain escort ships to perform comparable missions.

If helicopter operations from merchant ships prove to be successful, then the next step would be to replace the helos with fixed-wing VTOL (vertical takeoff and landing) aircraft. VTOL aircraft could increase the scope of merchant ship self-defense capabilities with longer-range reconnaissance, airborne early warning (AEW), and possibly the interception of long-range reconnaissance aircraft.

ARAPAHO would not be limited to containerships. Barge carriers, Ro-Ro's, bulk freighters, and tankers all are possible platforms, although more modifications would be required. The mission should not be limited to antisubmarine warfare or AEW. Other possible tasks are close air support for the Marine Corps, maritime surveillance, offensive tactical operations, minelaying, minesweeping, casualty evacuation and treatment, amphibious trooplift, and still more.

Other combat systems also seem logical candidates for container installation and use on merchant ships. Chaff launchers, which offer passive protection against antiship missiles, appear suitable for containerization. An active defense against antiship missiles which could fit into a container is the Close-in Weapons Systems (CIWS). This consists of a search radar, tracking radar, and a 20mm Phalanx Gatling gun. (See figure 4-12.) Additional containerized weapons of the future might include a simple torpedo launching system and a missile launcher for surface to air and antiship missiles.

The obvious advantage to equipping merchant ships with defensive and even offensive weapon systems is that it frees some of the limited number of naval escort ships to perform other crucial wartime tasks, without degrading the protection afforded merchant shipping. The provision of weapon systems, on modern merchant vessels, that are both portable and relatively efficient, seems to be a resonable investment in our national security.

WARTIME MISSIONS

National Defense Features represent and attempt, although a rather limited one, to lay the groundwork in peacetime for the effective use of the U.S. flag merchant marine in wartime.

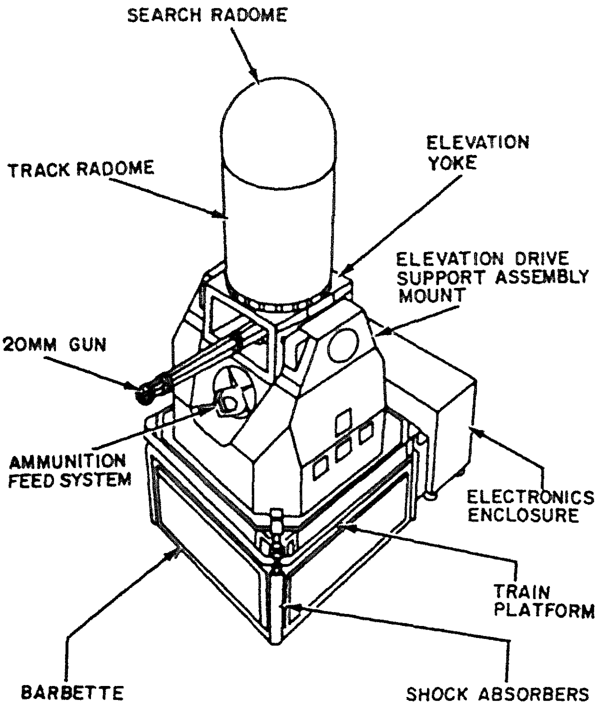


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Figure 4-12.—Main parts of the Vulcan-Phalanx gun mount.

The wartime tasks which the merchant fleet must be prepared to carry out include:

1. The transportation of materials and cargo essential to the U.S. economy and to assist in supplying the economic needs of overseas allies.
2. To resupply American and allied military forces overseas.
3. Provide underway replenishment for wet or dry cargo and other direct services to the Navy ships at sea.
4. To augment combatant naval forces by being armed to carry out convoy, antiaircraft, or antisubmarine duties.

THE NEED FOR WARTIME CONTROL OF SHIPPING

Shipping is the only resource for which standby requisitioning authority exists in peacetime legislation and the shipping industry is the only industry that is subject to immediate, complete federal control at the beginning of a national security emergency. These special arrangements for shipping are necessary because military forces cannot fight overseas without shipping support and, at the present level of

commercial shipping operations, nearly the entire American liner fleet is needed to meet military needs in a major conventional war. When a defense need arises, it is peremptory, for the merchant fleet as well as for the military services. Requisitioning of ships is necessary to meet that peremptory demand.

In a NATO war, military personnel and some equipment would move to Europe by air. But over 90 percent of the total deployment and resupply tonnage would move by sea, and ships would be needed immediately in large numbers. At the same time, arrangements would have to be made for waterborne imports of oil and over 50 million tons a year of other raw materials.

Emergency shipping plans are dominated by the need for fast reaction to military demands. In World War I and World War II, the United States had several years to gear up for war. Operations in Korea and Southeast Asia built up over relatively long periods. The United States will be in a future NATO conflict from the beginning. The transition from peace to war will be abrupt, particularly for the American shipping industry.

The existence of a state of war or of the declaration of a national emergency and the commencement of naval control will be announced by the Chief of Naval Operations or a Fleet Commander in Chief to merchant ships in a plain language general emergency message. This message will be broadcast through all available commercial and military communication systems. It will be similar to the following example:

"WGBC (ALL U.S. CONTROLLED MERCHANT VESSELS DE MMC (YOUR RADIO SERVICE COMPANY; e.g. RMCA, etc.) XXX XXX XXX (URGENT SIGNAL) FLASH 091717Z MAY 77 PRECEDENCE AND DATE-TIME GROUP)

FM: CHIEF OF NAVAL OPERATIONS WASHINGTON D.C. (ORIGINATOR)

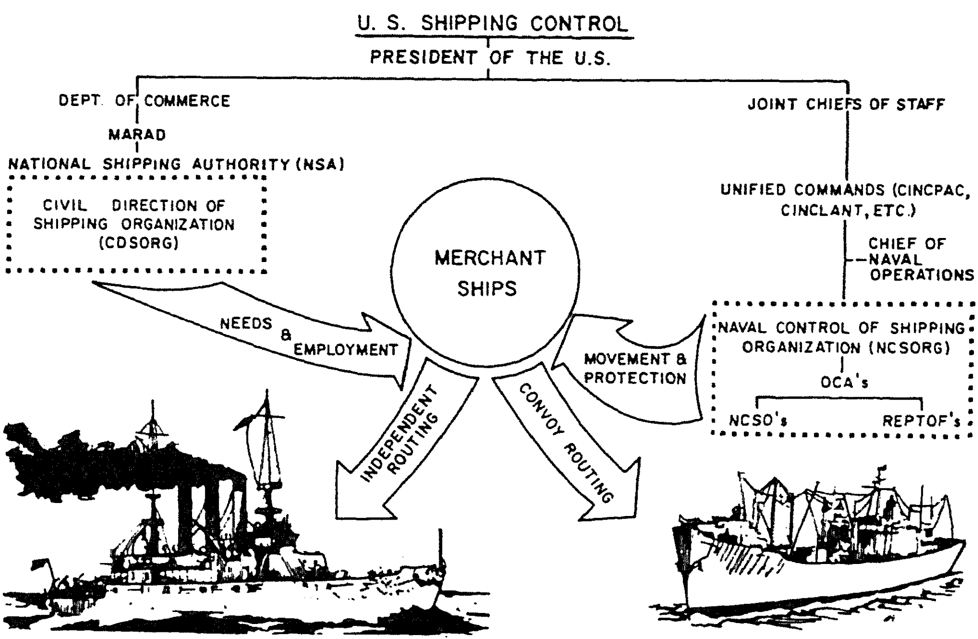
TO: ALL U.S. CONTROLLED MERCHANT SHIPS (ACTION ADDRESSEE)

GR 30 (WORD COUNT BETWEEN BTs) BT (BREAK) GENERAL EMERGENCY MESSAGE X UNITED STATES IS AT WAR WITH----X MASTERS OF U.S. CONTROLLED MERCHANT SHIPS COMPLY WITH INSTRUCTIONS CONTAINED IN HO 117 CHAPTER TEN AND ENVELOPE ALFA BY 091717ZAR"

From the time the master receives the general emergency message, his subsequent movements at sea will be subject to the direction of the national control of shipping organization. The national organization is divided into a civilian organization and a naval organization. (See figure 4-13.)

CIVIL DIRECTION OF SHIPPING—PEACETIME

The United States Shipping Board was established under the Shipping Act of 1916. Under



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rchant Marine Act of 1936, the United hipping Board was replaced by the United Iaritime Commission. In 1950, the United Iaritime Commission was in turn replaced 'ederal Shipping Board and the Maritime stration, with the head of the Federal g Board being, ex officio, the Maritime strator.

EDERAL TIME COMMISSION

12 August 1961, the Federal Maritime ssion (FMC) was established and tasked gulating the oceanborne foreign and c offshore commerce of the United States. time it was determined that the Commis- ıld consist of five presidentially-appointed sioners, each serving a term of five years, /hom serves as chairman. The appointees ndergo confirmation by the Senate. no more than three of the commissioners members of the same political party.

task of ensuring that United States ional trade is open to all nations on fair itable terms is the major responsibility of C. The commission is also charged with ng all parties protection against rized, concerted activity in the waterborne rce of the United States. Commission ibilities are satisfied through maintaining ance over steamship conferences and n carriers by water; assuring that only the rates on file with the commission are ; approving agreements between persons to the Shipping Act of 1916; guaranteeing eatment to shippers, carriers, and other subject to the shipping statutes; and g that adequate levels of financial respon- are maintained for the indentification of ers and clean-up of oil and hazardous ce spills.

regulatory power of the FMC over the ates filed with it depend on four basic

f the rates are filed by a state/government- ed carrier (for example, a U.S.S.R. state- ed carrier) and it is found that those rates ng subsidized allowing the U.S.S.R.- ed carrier to compete on unequal terms privately-owned competitors, then the

2. If the rates filed apply to domestic off-shore commerce of the United States (for example, ocean commerce between Los Angeles and Hawaii or Miami and the Virgin Islands), then the commission is authorized to disapprove rates found to be unjust or unreasonable and may order refunds.

3. If the rates filed resulted from a conference of carriers (for example, if four private shipping companies meet and establish a rate that will be charged over a given route) then the commission is authorized to disapprove those rates found to be detrimental to commerce or unjustly discriminatory between shippers or ports.

4. If the rates filed are not of any of the types described above, they do not require FMC approval but can be implemented only on 30-days' notice, with the exception that rate decreases may become effective upon filing. This requirement protects American importers and exporters from sudden rate fluctuations, which can hamper their ability to compete effectively in international markets.

Other responsibilities of the FMC include the licensing of independent ocean freight forwarders, passenger vessel certification, and certification of vessels to ensure fiscal responsibility for oil pollution and hazardous substance spills.

THE MARITIME ADMINISTRATION (MARAD)

MARAD is the agency designated to develop, promote, and maintain an efficient United States merchant marine, capable of meeting the nations' shipping requirements for commerce and defense. In August 1981, MARAD became a unit of the Department of Transportation, although it traces its history to the creation of the United States Shipping Board in 1916.

MARAD is headed by the maritime Administrator who is appointed by the president with the advice and consent of the Senate. The Maritime Administrator is assisted by two Deputy Administrators and by Associate Administrators for Policy and Administration; Marketing and Domestic Enterprise; Shipbuilding and Ship Operations; Maritime Aids; and Research and Development.

MARAD's legislative mandate is provided by the Merchant Marine Act of 1936 as amended. The policy statement formulated in 1936 remains

the years, have modified or redirected certain federal maritime policies and programs affecting the U.S. shipping and shipbuilding industries.

Under the 1936 and 1970 Merchant Marine Acts, several direct and indirect government assistance programs were established to assist U.S. citizens in shipbuilding and ship operations. These include:

1. The construction-differential subsidy (discontinued in 1983)
2. The operating-differential subsidy
3. Ship Financing Guarantees or Title XI
4. Capital Construction Funds

Construction subsidies helped equalize U.S. shipbuilding costs with lower foreign shipbuilding costs. Under this program, MARAD has awarded billions of dollars in subsidies for the construction of new merchant ships. Additionally, many breakbulk ships have been converted into highly efficient containerships. Unfortunately, CDS limited ships to international trade only. Many ships, especially oil tankers, found it more lucrative to conduct intra-U.S. trade, such as carrying oil from Alaska to the lower 48. Hence, the discontinuance of CDS.

Operating-differential subsidy is designed to place the U.S. flag fleet on a cost parity with foreign flag competitors. Subsidy is paid to offset the differentials in U.S. and foreign crew costs, insurance, and maintenance, and repair costs. The assistance helps to ensure regular and frequent U.S. flag shipping service between the United States and its overseas trading partners at reasonable rates.

Ship Financing Guarantees assist vessel operators in obtaining the private capital necessary to upgrade or expand their fleets. Vessels engaged in foreign or domestic trades, as well as offshore drilling operations, are eligible. Through the Title XI program, the United States government guarantees the payment of principal and interest on loans, thereby enabling the owner to obtain long-term commercial financing at favorable interest rates.

The Capital Construction Fund program permits U.S. flag vessel operators to deposit revenues into tax-deferred accounts to accumulate capital for the construction or reconstruction of vessels.

MARAD also is engaged in officer training programs. At the United States Merchant Marine Academy, Kings Point, N.Y., men and women are trained to become officers for the merchant marine. The Academy offers a four-year progra of study leading to a bachelor of science degre including shipboard training and a license as thi mate or third engineer. Academy graduates a commissioned as ensigns in the U.S. Nav Reserve.

Financial support is also provided to Sta Maritime Academies located in California, Main Massachussetts, Michigan, New York, and Texa and the agency supplies those on the Atlanti Pacific, and Gulf Coast with training ships. I addition, the agency operates five radar trainin centers and conducts firefighting and dama control courses for merchant seafarers at thre locations, with a fourth planned.

MARAD's Office of Ship Operations charged with promotion of the U.S.'s rapid growing domestic shipping industry, whic operates on the inland waterways, the Gre Lakes, and in the coastwise, intercoastal, an noncontiguous trades.

Through its Office of Market Developmen MARAD conducts comprehensive marketin program, to help the merchant marine increa the amount of cargo carried by U.S. flag ship Agency marketing representatives assist U.S. fla lines in marketing their services to exporter importers, and freight forwarders.

A significant part of MARAD's commerci development program involves port and inte modal development. Maximizing the benefits modern, highly productive vessels require specially designed systems and procedure modern port facilities and cargo-handling equi ment, and computers to follow cargo flow.

Another key to further productivity gains the U.S maritime industry is the agency's researc and development program, currently focused o three major areas. These areas are:

1. Maritime technology
2. Ship development
3. Ship operations

Programs to provide cargo forecasts an background data to develop new marine transpo tation concepts are being studied in the area maritime technology.

Ship development is concerned with turnin innovative concepts into ship designs and onboar equipment. For example, projects cost-share with shipyards are designed to improve the productivity through computerized productio methods, better fabrication and equipment, an improved ship designs.

Ship operational research is involved with ıproving the safety and efficiency of seagoing ssels. One key program is developing advanced ıvigation and communication techniques. In this ea, MARAD participated in the development a satellite communications system called ARISAT, which was in use in the U.S. shipping dustry from 1975 to 1982. In February 1982, ARISAT, was replaced by a second-generation stem known as INMARSAT.

Linking a number of MARAD program areas an effort to come to grips with the now ominant factor in the economics of shipping— e cost of energy. Among the agency's energy-lated activities are the following:

1. Encouraging a U.S. industry trend toward e powering of oceangoing vessels with energy-ficient diesel engines.
2. The establishment at the Merchant Marine cademy of a diesel engineering course for ensed marine engineers.
3. Numerous R&D projects involving various els, propulsion systems, and hull designs.

ıese and other government and industry efforts e expected to save operators of U.S. flag ships ındreds of millions of dollars each year.

THE UNITED STATES COAST GUARD

Subsequent to its establishment in 1790 as the evenue Cutter Service, the organization now ıown as the Coast Guard gained a number of lditional responsibilities. Between 1790 and 15, when the present Coast Guard came into ing, the Steamboat Inspection Service, Life-ving Service, Bureau of Navigation, Lighthouse rvice, and Bureau of Marine Inspection and avigation were added to the Revenue Marine. 1966, the agency responsibility for the Coast ıard was transferred from the Department of e Treasury to the Department of Transpor-tion.

The initial mission of the Revenue Cutter rvice was to stop smuggling—still a challenging sponsibility. Since its establishment, however, oast Guard missions have continued to expand d have become more complex.

A separate branch of the Department of ansportation in peacetime, the Coast Guard erates as part of the Department of the Navy wartime, or on other occasions when the president so directs. Its peacetime responsibilities and mission when part of the Navy would continue. They include port safety and security, commercial vessel safety, search and rescue, enforcement of U.S. laws and treaties, promoting recreational boating safety, providing aids to navigation, domestic and polar icebreaking, marine environmental protection, and bridge administration.

During the early 1980s, the Coast Guard was active in controlling and protecting refugees from Cuba and Haiti who fled their own countries in large numbers by boat. It also was active in the fight against drug smugglers and in patrolling U.S. fishing grounds.

Each Coast Guard responsibility is based on authority contained in U.S. statutes, primarily in Title 33 (Navigation and Navigable Waters) and Title 46 (Shipping) of the U.S. Code. More than 20 U.S. laws have been implemented by the Coast Guard.

During World War I and World War II, the Coast Guard served as part of the Navy. Typical duties performed included convoy and escort responsibilities, aerial patrols, and service aboard Navy ships. Amphibious assault operations were an important role of the Coast Guard in World War II. The role of the Coast Guard in the United Nations war in Korea was more limited. However, in the Southeast Asia war, the Coast Guard operated coastal and river patrols. This was a highly dangerous operation when you consider the nature of that war. Coast Guardsmen also supervised the loading and unloading of ammunition ships and ships carrying other types of hazardous cargo. As is obvious from its history, missions of the Coast Guard are global in nature and have been for some time. The title of the organization is quite misleading.

Coast Guard Headquarters is in Washington, D.C. Among the major elements of the headquarters are the offices of merchant marine safety, boating and safety, operations, marine environment and systems, and navigation. Twelve Coast Guard District Offices are dispersed in the Continental United States, Alaska, and Hawaii. The Coast Guard also maintains an office in Europe.

The Coast Guard controls the peacetime movement of all nonpublic vessels, those not owned or operated by the government, while such ships are in U.S. waters. That responsibility requires close coordination between the Coast Guard and law enforcement agencies, with Customs personnel, and with all elements of the

U.S. maritime industry. To carry out a wide range of tasks, the Coast Guard assigns Captains of the Port and officers in charge of marine inspection to key ports. Both operate under the control of a Coast Guard district. Usually, the two functions are combined in a Coast Guard Marine Inspection Office for key port areas.

A Captain of the Port is responsible for the safety and security of the port, for movement, berthing or anchorage of vessels within the port area, for loading and unloading operations, for storage and movement of ships' cargo along the waterfront, and for protection of the port environment. The latter function has become particularly important because of local sensitivity to any threat of oil spills or other pollution.

Coast Guard marine inspectors are responsible for enforcing all regulations pertaining to the inspection and certification of U.S. flag commercial vessels. They review the design and function of equipment and structures aboard ships, check certification and performance of Coast Guard documented mariners, and investigate major accidents or incidents involving property damage or loss of life.

Other duties include enforcement of loadline requirements, issuance of permits for hazardous operations, and enforcement of safety regulations of the Federal Water Pollution Act, the Ports and Waterway Safety Act, and a myriad of other safety and environmental legislative acts.

The growing range of its duties presented a major problem for the Coast Guard in the early 1980s. With more and more programs being assigned by Congress to the Coast Guard for monitoring or control, the agency often was stretched thin. Neither personnel nor ship assets had kept pace with its expanding role. As a result, efforts were initiated to modernize the Coast Guard's capabilities by construction of new and often highly specialized ships. That trend is expected to continue.

SUPPORT OF THE CIVIL ECONOMY

Commercial cargo movement, particularly in the North Atlantic, is sharply curtailed during the reinforcement period. The economic effect approaches the effect of a general longshoremen's or maritime labor strike lasting several months. However, a substantial commercial liner capacity remains available for U.S. trade, if the war at sea allows ships to continue to sail in commercial service, and the DOD support effort does not

bulk raw materials. Some commercial business disrupted, but the essential welfare of the nati is not harmed. When reinforcement is complete ships are released to resume support of t wartime essential civil economy.

CIVIL DIRECTION OF SHIPPING—WARTIME

During wartime, the Federal Maritime Co mission would continue to function in the capac previously described as directed by appropria authority.

THE MARITIME ADMINISTRATION

The National Shipping Authority (NSA) is t emergency shipping operations organization of t Maritime Administration. In the event of war national emergency, the peacetime MARA organization would be modified only to t extent necessary to bring the NSA into operati and to phase down peacetime activities that ha limited or no wartime application.

The NSA would be staffed mainly w people on duty with MARAD when the mobili tion plan was executed. The shipping indus would be asked to provide experts to fill po in the NSA and to serve as liaison officers fro the industry to the NSA. The Office of S Operations and the Office of Port and Intermo Development would be transferred to the N and augmented by persons obtained or reassign from other areas. The organization of t Associate Administrator for Shipbuilding a Ship Operations would be separated into t wartime organizations: the Shipbuildi Organization and the NSA. The Shipbuildi Organization would administer wartime sh building. Other MARAD elements would expa moderately to handle wartime tasks or pha down as the war situation diminished th activities.

Initial National Defense Support Operations

On the outbreak of war or the initiation reinforcement operations during a defense-relat emergency short of war, federal control would established immediately over all ships subject that control under the provisions of the Mercha Marine Act of 1936, as amended, and relat

.S. owned vessels when the security of the ational defense makes it necessary and in me of national emergency. The 1954 Emer-ency Foreign Vessels Acquisition Act authorizes equisition of foreign vessels lying idle in U.S. aters when U.S. vessels may be requisitioned nder the 1936 Act.

he National Shipping Authority

The National Shipping Authority (NSA) equivalent to the World War II War Shipping dministration. The NSA has continuing legal istence in peacetime and would be brought to full operation when the decision is made by e president to requisition ships.

hip Requisitioning

Shipping is the only resource for which andby requisiting authority exists in peacetime gislation, and the shipping industry is the only dustry that is subject to immediate, complete deral control at the beginning of a national curity emergency.

THE NATIONAL DEFENSE RESERVE LEET.—A presidential determination to requisi-on ships will activate several contingent thorities, the most important is the authority activate the previously mentioned National efense Reserve Fleet (NDRF). Although the eady Reserve Fleet of the NDRF will be placed berth for military loading in from 5 to 10 days, tivation of the rest of the Reserve Fleet could ot be completed in less than 45 to 60 days. Thus, serve ships will be increasingly important as eployment proceeds, but will not eliminate the eed to take commercial ships from trade to meet eployment requirements.

COMMERCIAL SHIPS.—So much of the ommercial fleet will be required for military use at the NSA would have no realistic alternative it to take the entire U.S. foreign trading general rgo fleet and some of the domestic fleet under ontrol. Some ships, particularly large RO/ROs, ill be requisitioned from domestic and noncon-guous trades for military use. LASH and EABEE barges will be requisitioned as vessels ong with the mother ships. Containers and ncillary equipment will not be requisitioned but ill be acquired under General Agency greements or under leasing contracts along with anagement services. Some product tankers will be requisitioned for military use, but initially most tankers will continue to operate in commercial service on commercial terms. Dry bulk carriers will continue to operate under commercial arrangements during the early stages of war or an emergency.

U.S. owned but foreign-registered ships are subject to requisitioning. Most are tankers or dry bulk carriers which would not be useful in direct military support operations but would be essential for support of the wartime civilian economy. As long as the ships continued to be responsive to the needs of the United States and their charter rates remained in line with NSA guidance, and in the absence of political or other reasons for requisitioning them, they would not be requisi-tioned. The NSA would monitor the operation of these ships and requisition them as necessary to meet national needs or maintain stability in U.S. and NATO shipping.

Disruption of trade in wartime is recognized as inevitable. Requisitioning of American ships will not, however, bring U.S. trade to a halt. Neutral shipping and much European NATO shipping will continue to serve U.S. liner trades while crude oil and raw materials movement will not be affected. Nevertheless, many current and future bookings on American flag carriers will be cancelled. Every effort will be made to minimize the impact of requisitioning on shippers and carriers. However, it should be noted that Section 902(a), Merchant Marine Act, 1936, provides that:

> "the owners shall not be paid for any consequential damages arising from the taking or use of property under the authority of this section."

CHARTERING.—The NSA will time-charter or bareboat charter requisitioned ships in accordance with Section 902(c), Merchant Marine Act, 1936, and operate the ships for government account. Owners will receive just compensation for the use of their ships, as provided in that section of the Act. The NSA will also time-charter non-U.S. ships made available for reinforcement sealift and will charter, or arrange for charter by U.S. operators, NATO European flag ships.

SERVICE AGREEMENTS.—NDRF ships and NSA-charted American and foreign ships will be operated by U.S. steamship companies as General Agents of the NSA, under standard forms of service agreements. The General Agents will

manage and conduct the business of vessels assigned to them. Normally ships chartered under requisition will be assigned for operation to their owners, but ships will be assigned and reassigned as necessary among General Agents to meet the needs of the United States. General Agents operating containerized shipping services will provide containers and ancillary equipment and will be paid for the use of the equipment and for system management, including inventory and locator services.

Support of the Department of Defense (DOD)

Ships under charter to DOD at the beginning of the emergency will remain under DOD charter. The NSA will allocate to DOD enough NSA chartered ships to cover military requirements at a sustaining level. Additional ships needed from time to time for surge or special requirements will be allocated for DOD use on a voyage or limited term basis. Allocated ships will be placed under operation control of the DOD but would not be subchartered to DOD. The NSA will be responsible for payment of charter hire to owners and will recover NSA costs from the DOD.

Some ships would be needed for operations with the Navy and a few might require substantial alteration. Ships in those categories would be bareboat chartered or requisitioned for title—that is, bought by the NSA—and subchartered or transferred to DOD.

Under the provisions of the Wilson-Weeks Agreement, the NSA would allocate to DOD, for operation under its exclusive control and jurisdiction, sufficient ships to provide capacity not to exceed 25 percent of the total capacity required to meet military requirements, as determined by the Joint Chiefs of Staff (JCS). Shipping space to meet additional DOD requirements would be provided by allocation on NSA-operated or NATO-operated berth space, by carriage of DOD cargoes on other NSA controlled ships, and by allocation of ships to DOD for single voyages or for specific periods. The NSA may allocate ships to DOD for service in specific continuing operations; for example, ships may be allocated to constitute an ammunition transportation service and a POL transport service. To the extent that such allocations exceed the 25 percent limit established by the Wilson-Weeks Agreement, the NSA will retain jurisdiction over the ships and share control with DOD.

Wartime Berth Service

The NSA will continue the operation
services to carry liner parcels on berth terms o
regular routes on such schedules as war conditio
permitted. Wartime berth services, includi
container services, will be operated by Gene
Agents for government account. Cargoes will
booked with steamship companies followi
standard commercial practices, subject to co
pliance with wartime export control regulatio
and movement priorities.

The NSA will publish tariffs for berth servic
operated for government account, initially in t
form of Rate Orders confirming commerc
tariffs, with war surcharges added. When t
NATO shipping pool is in operation, berth ra
within the NATO area will be agreed to by t
NATO member countries' shipping authoriti

The NSA would represent the United Sta
in wartime cooperative arrangements with NA
and other Allied countries for the regionalizati
of services and sailings, rates, container mana
ment, and so forth. General Agents will
appointed to act for the NSA in the wartime li
service management organizations which serv
the purposes of peacetime conferences.

The operations of neutral shipping compan
in U.S. trade will be regulated under existing la
subject to wartime policies and procedures. If t
NSA makes ships available for commerc
operation in U.S. neutral trades, the Fede
Maritime Commission (FMC) will regulate t
services in close coordination with the NSA.
the NSA operated ships for government accou
in U.S. neutral trades, the NSA will coordina
closely with the FMC.

Export Trade

Berth shipments aside, buyers will be expect
to provide ships to carry goods exported from t
United States. The NSA will coordinate arrang
ments for foreign flag lift on cargoes from U.
ports. In general, export sales will foll
peacetime lines within the framework of warti
export control regulations and movement prior
procedures and under State Department poli
guidance.

Freight Rate Policies

Charter hire and liner tariffs will be temp
rarily frozen at the beginning of the emergen
period. The NSA will set rates of charter hi

based generally on prewar rates, allowing for cost escalation in line with wartime wage and price control policies. Wartime increases in liner tariffs will be held to the level necessary to recover NSA costs.

War Risk Insurance

The NSA will provide hull, P & I, and second seaman's insurance for U.S. ships, U.S. owned ships, and other ships employed in U.S. trade or trading foreign to foreign with the approval of the NSA. The NSA will also insure cargoes of such ships and provide certain other insurance.

NATO Emergency Shipping Operations

The NATO member countries have agreed that upon the outbreak of war they will take ships of their flags under control and enter them in a pool. The general objectives will be to assure that NATO ships will be used in the overall best interests of the Alliance, that risks and losses will be shared, and that shipping costs will be kept under control.

Under the agreement, U.S. flag ships will be placed at the disposition of the Alliance and non-U.S. ships in return will be made available to meet U.S. military and essential civil shipping requirements. The NSA will act for the United States in chartering ships from the NATO pool. General Agents of the NSA, oil companies, and operators of proprietary dry bulk fleets will be appointed NSA agents for the chartering of ships from the NATO pool, when practicable. Pool ships chartered by the NSA will be subchartered to U.S. operators.

The NATO shipping pool will be managed by an international body designated the Defense Shipping Authority (DSA). The DSA will have executive authority; that is, power to direct the use of ocean-going ships of member countries.

In general, the DSA will rely on the NSAs of member countries to conduct shipping operations for the Alliance. Overseas representatives of NSAs will also act for the DSA, under arrangements worked out for each area by the NSAs concerned and the DSA.

Initial Situation Reports

U.S. companies regularly employ ships of many countries, including European NATO and other Allied countries. At the beginning of an emergency, the NSA will direct ship operators to report the ships they had under charter, the terms of the charter parties, and certain other information. The NSA will use the information to make arrangements with Allied governments for continuation of Allied flag ships in the service of the United States. Information on non-NATO ships will be used to support requests for NATO ships and to plan the overall national shipping program.

Emergency Control of Ports

Ocean ports are the operating link between the domestic transportation system and ocean shipping. Ocean shipping is an essential component of national defense—and ports are an integral part of the shipping system. NSA emergency shipping plans are structured for fast response to military needs. The United States must be able to move a substantial number of divisions to a foreign theater of operations within a few weeks. More than 90 percent of the tonnage required to deploy and support those divisions will move through ocean ports. Much larger tonnages of oil, dry bulk commodities, and manufactured goods will also continue to move through U.S. ports during emergencies.

United States port facilities are designed to handle all commodities traded in domestic and foreign commerce. Available port capacity is sufficient to meet the needs of large-scale foreign military operations in addition to the wartime economic requirements of the country. Nevertheless, some control measures will be necessary in time of war.

In a major conventional war, enemy anti-shipping operations will require close control of ship movements. Port operations will have to be coordinated with ship movements, as directed by the Naval Control of Shipping Organization, to avoid port congestion. Some rationalization of port operations will be necessary to make best use of available port facilities, labor, fuel, and other resources.

A nuclear attack on the United States will probably destroy some port facilities and probably make others unusable by disrupting land transportation services, utilities, and the supply of port workers. Following nuclear attack, direct government control of ports will be necessary at least temporarily, and possibly for a considerable time, to meet the needs for support of military forces deployed overseas, essential foreign trade, and domestic trade.

Government control would be exercised only to the degree required by the emergency. These controls would be designed to:

1. Assure the coordinated handling and free flow of cargo and passengers to, from, and within port areas in support of national objectives
2. Make the best use of available resources
3. Prevent port congestion

THE GENERAL PLAN.—Planning for emergency port operations is based primarily on a major conventional war scenario. Under that scenario, ports will operate as much as possible as in peacetime. The NSA would control use of common-user port facilities by administering movement priorities and supervising traffic flow. Facilities will be allocated only where government agencies required exclusive use.

Following an attack upon the United States which might destroy or deny use of a significant fraction of U.S. port capacity, all shipments through U.S. ports will be placed under control, and port operations will be directed by the NSA. While coordinating the restoration of damaged port facilities, the NSA will make the most efficient use of undamaged port capabilities by controlling the flow of cargo and the movement of ships, by allocating the use of port facilities, and by other means appropriate under the circumstances.

Federal control of ports in nonmobilization contingencies is not forseen.

FEDERAL PORT CONTROLLERS.—A Federal Port Controller will be the official local representative of the NSA. The Port Controller will transmit directions of the NSA to local port officials, coordinate execution of those directions, and report the status of port operations to the NSA. Normally the Controller will be the Director of the Port or the Director of Marine Operations of a local port authority. The Controller will serve under a contract between the NSA and a local port authority or private corporation, under which the local authority or corporation provides administrative support and agrees to make the incumbent of a specified position in the local organization available for duty as the Federal Port Controller.

The Port Controller's duties would depend on the conditions of the emergency. In a conventional war, those duties might consist largely of a watching brief on behalf of the NSA until difficulties developed. In the aftermath o nuclear attack, the Port Controller will exerc direct operating authority within his designa geographic area. In any case, the Port Contro will be responsible for ensuring effective a efficient coordination between shipping mana ment activities in the port, port operations, Na Control of Shipping activities, and port secu activities.

U.S. NAVAL CONTROL OF SHIPPING ORGANIZATION (NCSORG)

Among the tasks assigned to the Departm of the Navy by the Secretary of Defense, with approval of the president, are the organizati training, and equipping of naval forces for protection of shipping (see DOD Direct 5100.1). One proposition under which the Na acts to exercise control of shipping in time of or emergency is the authority derived from president under his general power as Comman in-Chief to wage war.

On 19 July 1950, the U.S. Naval Con of Shipping Organization (NCSORG) established under the cognizance of the CNO part of the Operating Forces of the Navy. discharge the responsibilities of the Navy for control and protection of merchant shipping, following functions were assigned to the eleme of the U.S. NCSORG. These functions are to carried out in a manner consistent with the operational command vested in Unified Specified Commanders.

In addition, U.S. NCSORG activities are participate in an Allied NCSORG when directed.

The mission of the NCSORG is to provide the safety of movement of merchant ships in ti of war or national emergency and in peaceti to prepare for executing that mission.

The objective of the NCSORG is to estab and maintain an effective nucleus organizat capable of orderly expansion and effective tr sition from peacetime operations to the execut of its wartime task immediately on the outbr of war or on the declaration of natio emergency.

In carrying out these objectives, the NCSO performs the functions of routing, reporti diversion of shipping, and where necessa organization of convoys. While not within scope of their NCSORG responsibilities,

same major naval commanders who control routing and sailing also control the assignment and employment of patrol and escort forces charged with protection of national and allied merchant shipping.

The Chief of Naval Operations is primarily responsible for the overall direction of the organization and the development of plans and policies. Operational control and protection of shipping rests with the Commander in Chief, U.S. Atlantic Fleet (CINCLANTFLT), the Commander in Chief, U.S. Pacific Fleet (CINCPACFLT), and the Commander in Chief, U.S. Naval Forces, Europe (CINCUSNAVEUR). They delegate some of their operational control functions to area commanders who are known as Operational Control Authorities (OCAs).

The OCA is the naval commander responsible for the control of the movements and the protection of merchant ships within specified geographical limit. Within their area of responsibility the OCAs are required to: (1) maintain communication systems to disseminate operational information; (2) sail ships in convoy or as independents in accordance with the policies in force; (3) coordinate the control of shipping movements with contiguous naval commands; (4) provide protection in port and at sea for merchant ships under their control and (5) maintain operational control of the Naval Control of Shipping Officers and Reporting Officers within their commands. The OCA may be an Allied or U.S. commander, depending on the geographic location of his area or responsibility. In either case, his tasks are the same.

The Naval Control of Shipping Officer (NCSO) may also be either a U.S. or Allied naval officer. The NCSOs are the main and indispensable points of contact between OCAs and the ships prior to sailing. They control and coordinate the routing and movements of convoys and independents, subject to the directions of the OCAs.

The NCSO normally is answerable to the OCA, although there may be circumstances where he reports directly to a lower echelon in the chain of command. An example would be the NSCO at a small port serving under a more senior NCSO responsible for shipping control at a larger port in the same area.

Besides the general functions of the NCSO, his basic responsiblity is to organize and route transocean and coastal convoys. Included in organizing and routing are dissemination of the actual routes to be followed and the details of departure, rendezvous, and convoy breakoff into so-called "leaver" sections. Particulars are worked out in the convoy conference held immediately prior to departure of the ships. The NCSO must make all the necessary arrangements for the conference. It is also his duty to conduct the conference so there will be a free interchange of information, and ideas between the convoy commodore and his staff, the escort force commander and his individual commanding officers, the masters of the merchant ships, and the NCSO himself. If time permits, the NCSO is also charged with leading a conference on communications to disseminate communication requirements and limitations for the voyage and to settle any problems that may arise.

In addition to his basic responsibility—organizing and routing convoys and routing independents—the NCSO is also required to report the movement of merchant ships.

Another link in the NCSORG is the Reporting Officer (REPTOF). This officer may be a consular official appointed by the State Department, a civilian official appointed from another part of the executive department (usually from the Maritime Administration), an officer of the Armed Forces, or a representative of an Allied government. The REPTOF may be assigned in peacetime (and definitely will be assigned in emergency) to a small port of insufficient size to warrant an NCSO. Generally, ships sailing to small ports are given their return routes in advance, so that the primary duty of the REPTOF is to report their arrivals and departures to the OCA. It may be necessary on occasion for the REPTOF to route merchant ships and perform other tasks of an NCSO.

In wartime, or during a period of strained international relations, REPTOFs are responsible for:

1. Reporting the names, intended dates of departure, and destinations of all Allied and neutral merchant ships in their port when shipping controls are put into effect, and the subsequent arrivals and sailings of those ships.

2. Reporting the names and as much information as possible about intended movements of all potentially hostile ships in port, and subsequent arrivals and departures of such ships.

3. Sailing and routing, when directed, all Allied merchant ships and neutral merchant ships under Allied charter.

In carrying out its assigned responsibilities, the NCSORG performs four general functions: organizing, routing, reporting, and diverting merchant shipping. The degree to which each of these functions is exercised depends on the level of the organization and the specific circumstances.

An additional aspect of the mission of the NCSORG-liaison deserves mention. Because of the extensive national and international nature of merchant ship control, there is a continuing requirement for a high degree of interagency liaison and cooperation.

Depending on the world situation, the NCSORG has two distinct phases of operation. In peacetime it stands ready to provide the necessary degree of naval control for the sealift required in limited or brushfire war. At the same time, the peacetime NCSORG is a nucleus about which the organization may be expanded in a general war.

NAVAL CONTROL OF SHIPPING OFFICER AND CIVIL SHIPPING AUTHORITY COORDINATION

Activities of the Naval Control of Shipping Officer (NCSO) and civil port authorities are normally carried out concurrently and therefore must be carefully coordinated to maximize use of port facilities and minimize mutual interference. The NCSO is indirectly concerned with the bunkering, provisioning, loading or discharging of cargoes, crewing, and the material status of the merchant ships in his port scheduled to sail in convoys or independently. The local NSA representative, or in practice, a local shipping company office or agent, is responsible for correlating these activities and keeping the NCSO informed on the status of each ship. Based on the information received, the NCSO informs the area Operational Control Authority (OCA) which ships will meet their sailing schedules. The OCA issues sailing orders for ships reported ready for sailing. In the event problems develop which affect sailing schedules, the NCSO would coordinate solutions to those problems with the Federal Port Controller.

The NCSO is responsible for promptly notifying the civil port authorities of expected ship arrivals to assist in berth scheduling and arrangements for port facilities and services to facilitate prompt discharge and clearance of cargoes. If scheduled ship arrivals exceed the berthing capacity or labor and equipment are not available for unloading or servicing ships, the Federal Port Controller will make arrangements thro the NCSO for diverting ships to adjacent po The NCSO will inform the OCA of ships assig new destinations. The OCA will then i destination change messages to the Escort F Commander or master involved.

CONTROL OF MILITARY SEALIFT COMMAND (MSC) SHIPS AND MERCHANT SHIPS UNDER MSC AUTHORITY

During normal peacetime operations, M commands are responsible for controlling movements of MSC shipping, in accordance MSC's single manager service assignment ocean transportation. For training purp during peacetime, MSC shipping may placed under NCSORG control as set fort OPNAVINST 3450.8.

During contingency situations it may necessary or desirable to shift the responsib for controlling MSC shipping from MSC NCSORG. If at any time during conting operations, a Fleet Commander in Chief consi it appropriate that the peacetime NCSO control MSC shipping, he may assign this tas the NCSORG in his area of responsibility.

If a danger area has been designated the U.S. wants the NCSORG control ship within that area only, the cognizant M area commander will be directed by the F Commander in Chief to place specified M shipping under NCSORG control or to sail M shipping to a MSC designated assembly p anchorage to report to the NCSORG for con Upon leaving the danger area, MSC shipping revert back to MSC control. In any case, w a Fleet Commander in Chief considers it propriate to assign the responsibility for cont ling the movements of MSC shipping to NCSORG, he will notify the appropr commands.

During war or a declared national emerge responsibility for controlling the movement merchant shipping, including MSC shippin vested with the NCSORG.

ALLIED NAVAL CONTROL OF SHIPPING ORGANIZATION (NCSORG)

Worldwide naval control of shipping w be exercised as required through agreements

Allied governments by the Allied high command. The structure of the Allied Naval Control of Shipping Organization, as defined in ATP 2.

There can be no clear dividing line between the Allied and U.S. aspects of the NCSORG, particularly in the lower echelons, since the same organization serves both functions and uses the same reporting systems. With respect to the assumption of Allied major area commander and area commander responsibilities within the U.S. NCSORG, the Fleet Commanders in Chief have, as previously noted, been so tasked by the CNO.

RELATIONS WITH MILITARY SEALIFT COMMAND (MSC)

Department of Defense shipping operations are managed and conducted by MSC. MSC representatives are present in all ports where DOD ships call.

Many ships under operational control of MSC in wartime are NSA ships operated under General Agency Agreements. All costs for operation of such ships are paid by General Agents, for account of the NSA, and reimbursed by MSC at the national level.

NSA regional offices would assist MSC representatives in all possible ways to facilitate ship operations and expedite turnaround.

PORT TRAFFIC CONTROL

Port conditions would dictate the nature and extent of controls imposed on port traffic. The NSA would coordinate the ocean shipping program to support U.S. military, essential civil, and approved foreign military and civil supply programs, and would issue blanket releases to cover shipments to ports against those programs.

The Interstate Commerce Commission (ICC) would control the flow of traffic to ports, in accordance with the export program of the NSA. The port traffic control system would be based on the issuance of export licenses by the Department of Commerce and movement priorities issued in accordance with procedures established by the Department of Transportation. In a NATO war, movement priorities based on NATO supply and production program priorities would be recognized.

The NSA would issue port calls for cargo booked to specific sailings and for cargo to be assembled for coordination and movement overseas.

EMERGENCY BERTH UTILIZATION REPORTING SYSTEM (EBURS)

In the United States, there are some 190 ports capable of handling ocean-going vessels, 1,500 terminals, and over 2,900 berths subject to NSA control during war or defense-related national emergencies. EBURS is designed to enable the NSA to keep track of operational berth availability on a current basis. In conjunction with an automated inventory of the characteristics and capabilities of U.S. port facilities, EBURS provides the NSA with a continually updated portrayal of the situation in all ports during an emergency and enables the NSA to assign and reassign ships to ports, terminals, and berths. If certain ports or port facilities became unavailable while ships are en route, the system provides the NSA with information required to divert the ships.

THE UNITED STATES COAST GUARD

The primary wartime mission of the Coast Guard would be port safety and security, an essential element of military strategic mobility. With ships expected to carry 90 percent or more of the volume of troop support equipment and supplies in any future war, most of that volume would pass through strategically located ports that would represent prime targets for the enemy. Protecting the security of these ports and adjacent waterways would pose a significant problem for any organization.

OTHER WARTIME CIVILIAN CONTROL AUTHORITIES

The policy for control of fishing vessels in time of war or emergency is based on a combination of civil and naval control of those vessels. The civil control authorities involved in that activity as well as their responsibilities are discussed at length in chapter 8.

OTHER CIVILIAN INVOLVEMENT

While this chapter has identified most of the national agencies directly involved in the direction of merchant shipping, their involvement should by no means be considered exclusive. A number of other civil organizations, agencies, and committees have contributed in the past, and will continue to contribute, to a successful maritime effort both in war and in peace.

IN PEACETIME

The predominant concern of this chapter has been the partnership of the U.S. merchant marine and Navy in preparing for and operating together during an armed conflict. However, the Navy also offers assistance to U.S. flag ships in peacetime when they are in distress or need protection.

Every merchant officer should be aware that a merchant ship is considered, under international law, to be a part of the territory of the country in which it is registered. The master must recognize and comply with all international laws that this country recognizes, such as the Regulations for Preventing Collisions at Sea, in addition to national laws.

One of the provisions of international law that is applicable to merchants is that there are only periods of peace or declared wars. Periods of international tension or undeclared wars are considered as peacetime, regardless of the threat to ships at sea. During periods short of declared war, one nation may try to provoke another by harassing its merchant ships. This violates international law by interfering with a ship's right of free passage on the high seas. In spite of any provocation, it is necessary for any vessel being harassed to continue to comply with all international laws, including the rules of the road.

The manner of the harassment could take the form of maneuvering to cause a collision, restricting the entry of merchants into areas considered international water, firing weapons at merchant ships, or boarding and seizing merchant vessels.

The first course of action to be taken by the ship is to advise the owner and the government of the incident by an urgent or distress message. If necessary and available, naval forces will be dispatched to provide protection. In the inter
the master must determine if it is prudent
continue on his voyage or await instructions a
assistance.

An example of such a situation occurred
May 1975 when the U.S. flag vessel, S
Mayaguez, was seized in international waters
the coast of Cambodia. Prompt action by Na
Marine Corps, and Air Force units was
contributing factor to the safe return of the sl
and crew. Eighteen American servicemen w
killed during the rescue effort.

During any harassment incident a detail
record, including photographs, should be ke
Upon arrival in port, extracts of all log entri
plots, records of signals exchanged, a
photographs should be delivered to the owner
the nearest embassy or consulate office.

IN WARTIME

During a declared war, according to int
national law, a merchant ship is considered to
a noncombatant and may not interfere with t
free passage of other ships. It has the right to
its defensive armament against an enemy who
clearly attempting to capture or sink it. T
master, however, accepts the risks which m
result from the enemy's use of force to overco
his resistance. To avoid capture, it is a
permissible to use false colors or alter the shi
appearance, when authorized by the country
registry.

There are other legal aspects of operati
merchant ships at sea during wartime, but ea
master should assess the feasibility of relying
international law to govern the behavior
belligerent nations in wartime. Close cooperati
with the Navy may prove to be a more prude
course of action.

CHAPTER 5

U.S. NAVY ORGANIZATION

At the end of World War II there were two military (executive) departments in the United States: Department of the Navy, including naval aviation and the U.S. Marine Corps; and the Department of War, which included Army Air Forces. Each of the departments was headed by a secretary who was a member of the President's Cabinet.

In 1947, Congress passed the National Security Act, which created the National Military Establishment (NME) to be headed by a Secretary of Defense; established a Department of the Air Force as a third military (executive) department; changed the title of the Department of War to Department of the Army; and provided for transfer of air force functions from the Department of the Army to the Department of the Air Force. It further provided for establishment of unified commands in strategic areas. In 1949, amendments to the Act established the Department of Defense as an executive department, with the Departments of the Army, Navy, and Air force as military departments therein, to replace the NME (fig. 5-1). Secretaries of the military departments were replaced as cabinet members by the Secretary of Defense. These amendments also created the position of Chairman of the Joint Chiefs of Staff.

The Department of Defense was created as part of a comprehensive program for the future security of the United States through the establishment of integrated policies and procedures for the departments, agencies, and functions of the government relating to national security. In enacting such legislation, it was the intent of Congress to

1. provide a Department of Defense, which would include the departments of the Army, Navy (including naval aviation and the United States Marine Corps), and Air Force under the direction, authority, and control of the Secretary of Defense;
2. provide that each military department would be separately organized under its own secretary and function under the direct authority, and control of the Secretary of Defe
3. provide for their unified direction u civilian control of the Secretary of Defense not to merge the departments or services;
4. provide for the establishment of unifie specified combatant commands, and a clear direct line of command to such commands
5. eliminate unnecessary duplication in Department of Defense, particularly in the of research and engineering, by vesting its ov direction and control in the Secretary of Defe
6. provide more effective, efficient, economical administration in the Departmer Defense; and
7. provide for the unified strategic direc of the combatant forces, for their operation u unified command, and for their integration an efficient team of land, naval, and air fo

ORGANIZATION OF THE DEPARTMENT OF DEFENSE

The Department of Defense maintains employs armed forces to

1. support and defend the Constitution o United States against all enemies, foreign domestic;
2. ensure, by timely and effective mili action, the security of the United States, possessions, and areas vital to its interest;
3. uphold and advance the national pol and interests of the United States; and
4. safeguard the internal security of United States.

The Department of Defense includes

1. the Office of the Secretary of Defen
2. the Joint Chiefs of Staff and the J Staff;
3. the three military departments and military services within those departments;

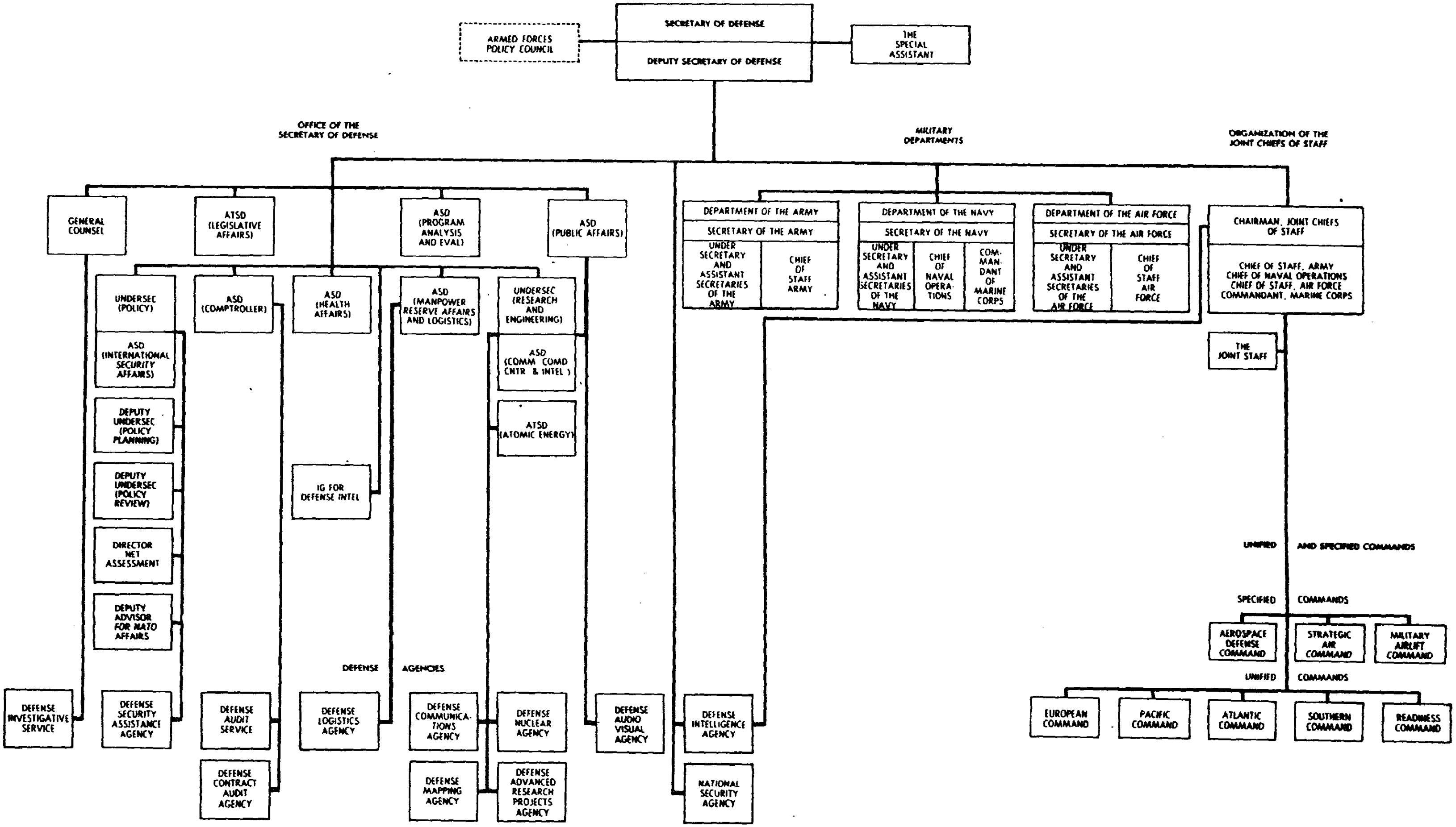


Figure 5-1.—Organizational chart for the Department of Defense.

SECRETARY OF DEFENSE

The Secretary of Defense is the principal assistant to the President in all matters relating to the Department of Defense. All functions in the Department are performed under his direction, authority, and control.

The Deputy Secretary of Defense performs such duties and exercises such powers as the Secretary of Defense prescribes. He acts for, and exercises the powers of, the Secretary when the latter is absent or disabled.

The Secretary and Deputy Secretary of Defence are appointed from civilian life by the President with the advice and consent of the Senate. They may not have been regular commissioned officers of the Armed Forces within 10 years preceding their appointments.

The Office of the Secretary of Defense (OSD), which provides immediate staff assistance and advice to the Secretary, includes the offices of the Director of Defense Research and Engineering, a number of Assistant Secretaries of Defense, the General Counsel of the Department of Defense (DOD), and other staff offices the Secretary may establish to assist him in carrying out his duties and responsibilities.

Duties of the Director of Defense Research and Engineering include

1. acting as principal advisor to Secretary of Defense (SECDEF) on scientific and technical matters,
2. supervising all DOD research and engineering activities, and
3. directing and controlling research and engineering activities that the Secretary deems to require centralized management.

JOINT CHIEFS OF STAFF

The Joint Chiefs of Staff (JCS) consist of a chairman who may be of any service, and who is appointed by the President with the advice and consent of the Senate; Chief of Staff, U.S. Army; Chief of Naval Operations; Chief of Staff, U.S. Air Force, and the Commandant of the Marine Corps.

The JCS, supported by the Joint Staff, constitute the immediate military staff of the Secretary of Defense. In addition, the Joint

Subject to the authority and direction o President and the Secretary of Defense, the Chiefs of Staff, in addition to such other c as the President and SECDEF may direct responsible for the following tasks:

1. Prepare strategic plans and provide fo strategic direction of the armed forces, inclu the direction of operations conducted by manders of unified and specified comman
2. Prepare integrated plans for mi mobilization and integrated logistic plans.
3. Recommend to the Secretary of De the establishment and force structure of ur and specified commands.
4. Review the plans and programs of manders of unified and specific command
5. Review major personnel, material, logistic requirements of the armed forc relation to strategic and logistic plans.
6. Establish doctrines for unified opera and training and for coordination of the mi education of members of the Armed Forc
7. Provide the Secretary of Defense statements of military requirements and stra guidance for use in the development of buc foreign military aid programs, industrial mol tion plans, and programs of scientific researc development.
8. Recommend to the Secretary of De the assignment of primary responsibilit any function of the armed forces requiring determination, and the transfer, reassignn abolition, or consolidation of such functi
9. Provide United States representation c Military Staff Committee of the United Na and, when authorized, on other military s boards, councils, and missions.

UNIFIED AND SPECIFIED COMMANI

Unified and specified commands are e lished under the Joint Chiefs of Staff to ex command over all forces in a specific area c world or to otherwise carry out a b continuing mission (fig. 5-1). The cha command leads from the President to Secretary of Defense and through the Joint C of Staff to the commanders of unified or spe commands.

The main distinction between a unifie specified command is that the former is com

of two or more services while the latter normally consists of forces of only one service.

Periodically, the Joint Chiefs of Staff must decide which service will exercise command responsibility in a given area of the world. Then, they select a man from the chosen service to represent them as unified commander, the appointment being confirmed by the Secretary of Defense and the President. The unified commander has operational control over all forces in his area; service commanders are referred to as his component commanders. For example, in the Pacific, the JCS unified commander has the title of Commander in Chief, Pacific (CINCPAC). His component commanders are the Commander in Chief, U.S. Pacific Fleet (CINCPACFLT), and the area Army (USARPAC), Air Force (PACAF), and Marine Corps (FMFPAC) commanders. Component commanders retain direct control over their own forces, but are responsible to CINCPAC for the readiness of those forces.

A specified command is responsible for the performance of a specific mission. For example, the Strategic Air Command is a specified command responsible for preparing strategic air forces for combat and conducting strategic air operations.

DEFENSE AGENCIES

The directors of the Defense Nuclear Agency, Defense Communications Agency, Defense Intelligence Agency, and the Defense Mapping Agency are responsible to the Joint Chiefs of Staff for the operations and efficiency of their agencies. The Directors of the Defense Supply Agency, Defense Contract Audit Agency, Defense Civil Preparedness Agency, Defense Security Assistance Agency, and the Defense Advanced Research Projects Agency are responsible directly to the Secretary of Defense.

MILITARY DEPARTMENTS

The chain of command for purposes other than the operational direction of unified and specified command runs from the President to the Secretary of Defense to the secretaries of the military departments.

The duties of the military departments under their respective secretaries are to prepare forces and establish reserves of equipment and personnel equipped and trained for employment to meet the needs of war or an emergency; to organize, train and equip forces for assignment to unified or specified commands; to prepare and submit to the Secretary of Defense budgets for their respective departments; conduct research; develop tactics, techniques, and weapons; and to assist each other in the accomplishment of their respective functions, including the provisions of personnel, intelligence, training, facilities, equipment, supplies, and services.

The Army is responsible primarily for the conduct of prompt and sustained combat operations on land.

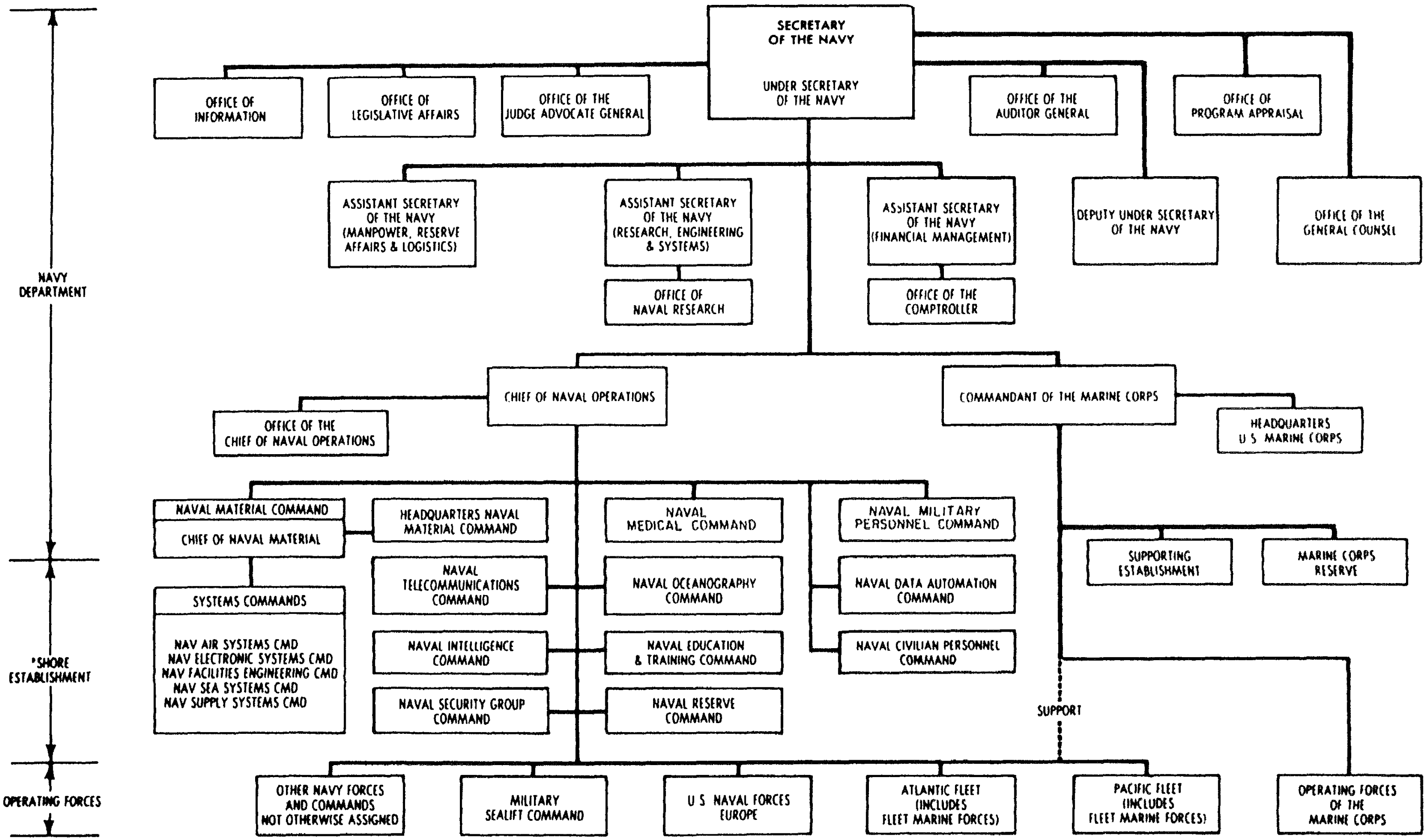
The Air Force is responsible mainly for prompt and sustained offensive and defensive aerospace operations.

The purpose of the remainder of this chapter is to provide a clear picture of the function of the Navy within the Department of Defense.

COMPOSITION OF THE DEPARTMENT OF THE NAVY

The Department of the Navy (DON) includes the entire naval component of the Department of Defense. It is composed of the Navy Department (the executive part of the DON, located at the seat of Government); Headquarters, United States Marine Corps; all operating forces, including naval aviation, of the Navy and Marine Corps, and the Reserve components of the operating forces; and all shore (field) activities, headquarters, forces, bases, installations, and functions under the control or supervision of the Secretary of the Navy (SECNAV). The Department (fig. 5-2) includes the U.S. Coast Guard when it is operating as a service in the Navy (in time of war or when the President so directs). The primary mission of the Navy is to be prepared to conduct prompt combat operations at sea in support of U.S. national interest.

The fundamental objectives of the Department of the Navy are to (1) organize, train, equip, prepare, and maintain the readiness of the Navy and Marine Corps forces for the performance of military missions as directed by the President or the Secretary of Defense, and (2) support Navy and Marine Corps forces, as well as the forces of other military departments that are assigned to unified or specified commands, as directed by the Secretary of Defense. As used here, support includes administrative, personnel, material, fiscal support, and technological support through research and development.



* Also includes other designated shore activities, not shown on the chart, which are under the command or supervision of many of the organizations depicted.

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Figure 5-2.—Organizational chart for the Department of the Navy.

EXECUTIVE ADMINISTRATION OF THE DEPARTMENT OF THE NAVY

Members of the executive administration of the DON include the following:

1. Secretary of the Navy
2. Civilian executive assistants to the Secretary of the Navy
3. Staff assistants to the Secretary of the Navy
4. Chief of Naval Operations
5. Chief of Naval Material
6. Commander, Naval Medical Command
7. Chief of Naval Personnel
8. Commandant of the Marine Corps
9. Judge Advocate General of the Navy
10. Chief of Naval Research

Secretary of the Navy

The Secretary of the Navy is the head of the Department of the Navy. Under the direction, authority, and control of the Secretary of Defense, he is responsible for the policies and control of the DON, including its organization, administration, operation, and efficiency.

Chief of Naval Operations

The Chief of Naval Operations (CNO) is the senior military officer of the Department of the Navy. He takes precedence above all other officers of the naval service except one who may be serving as Chairman of the Joint Chiefs of Staff. He is the principal naval adviser to the President and the Secretary of the Navy on the conduct of war, and the principle naval advisor and naval executive to the Secretary on the conduct of the activities of the Department of the Navy. The CNO is the Navy member of the Joint Chiefs of Staff; he is responsible for keeping SECNAV fully informed on matters considered or acted upon by the JCS. In this capacity, he is responsible under the President and SECDEF for duties external to the Department of the Navy as prescribed by law.

Internal to the administration of the Department of the Navy, CNO commands (1) the operating forces of the Navy, and (2), at the Navy Department level, the Naval Material Command, the Naval Military Personnel Command, the Naval Medical Command, and assigned shore activities. Except for those areas in which responsibility rests with the Commandant of the Marine Corps, CNO exercises overall authority throughout the Department of the Navy in matters essential to naval military administration, such as security, intelligence, discipline, communications, and matters related to the customs and traditions of the naval service.

With respect to the operating forces of the Navy, the Chief of Naval Operations has the following specific responsibilities:

1. To organize, train, prepare, and maintain the readiness of Navy forces, including those to be assigned to unified or specified combatant commands for the performance of military missions as directed by the President or SECDEF. This includes the responsibility to make or initiate any special provisions that may be required within the Department of the Navy for the administration of naval forces that are assigned to such combatant commands. Inherently, this responsibility includes determination of the training required to prepare Navy personnel, including Reserve personnel, for combat. Naval forces, when assigned, are under the full operational command of the commander of the unified or specified combatant command to which they are assigned.

2. To plan for and determine the material support needs of the operating forces of the Navy (less Fleet Marine Forces and other assigned Marine Corps forces), including equipment, weapons or weapons systems, materials, supplies, facilities, maintenance, and supporting services.

3. To plan for and determine the present and future needs, both quantitative and qualitative, for personnel (including Reserve personnel) of the Navy. This includes responsibility for leadership in maintaining (1) a high degree of competence among officers and enlisted personnel through education, training, and equal opportunities for advancement, and (2) the morale and motivation of Navy personnel and the prestige of a Navy career.

4. To plan for and determine the needs for the care of the health of the personnel of the Navy and their dependents.

5. To direct the organization, administration, training, and supply of the Naval Reserve.

OPERATING FORCES OF THE NAVY

The operating forces of the Navy include several fleets, seagoing forces, Fleet Marine Forces and other assigned Marine Corps forces, the Military Sealift Command (MSC), and such Navy

shore (field) activities and commands as are assigned by the Secretary of the Navy. The Chief of Naval Operations is responsible to the Secretary of the Navy for the command and material support of the operating forces of the Navy. With respect to those Navy and Marine Corps forces assigned to unified and specified combatant commands, this responsibility is discharged in a manner consistent with the full operational command vested in the unified and specified combatant commanders.

The Commanders of Pacific Fleet, Atlantic Fleet, Naval Forces Europe, and the Military Sealift Command report to CNO for conduct of training, logistic support, and for administrative purposes. The composition of the Pacific and Atlantic Fleets is shown in figure 5-3. Ships and craft are organized into major commands by types, which are self-explanatory; for example, Surface Forces, Naval Air Forces, Submarine Forces, Fleet Marine Forces, and training commands. The commanders of these forces (type commanders) report to the Commander in Chief, Pacific Fleet (CINCPACFLT), or Commander in Chief, Atlantic Fleet (CINCLANTFLT), as appropriate.

The numbered operating fleets, as elements o the operating forces of the Navy, are the Thir and Seventh Fleets of the Pacific Fleet, th Second Fleet of the Atlantic Fleet, and the Sixt Fleet under U.S. Naval Forces, Europ (USNAVEUR). Each of these numbered fleets a component part of a unified command and under the operational command of a unifie commander. The forces or type ships, whic make up the numbered fleets, are provided b the type commanders. Each ship is under th administrative command of a type commander fo training, readiness, and maintenance. As a example, a destroyer in the Atlantic Fleet under the administrative command of Com mander, Surface Force Atlantic, and under th operational control of one of the operationa commanders such as Commander, Second Flee

The delineation of two different lines o command, operational command and ad ministrative command, while not exclusively Navy arrangement, is of particular significanc to the Navy. Experience has shown that units o tactical organizations cannot operate efficientl if they are burdened with extensive administrativ

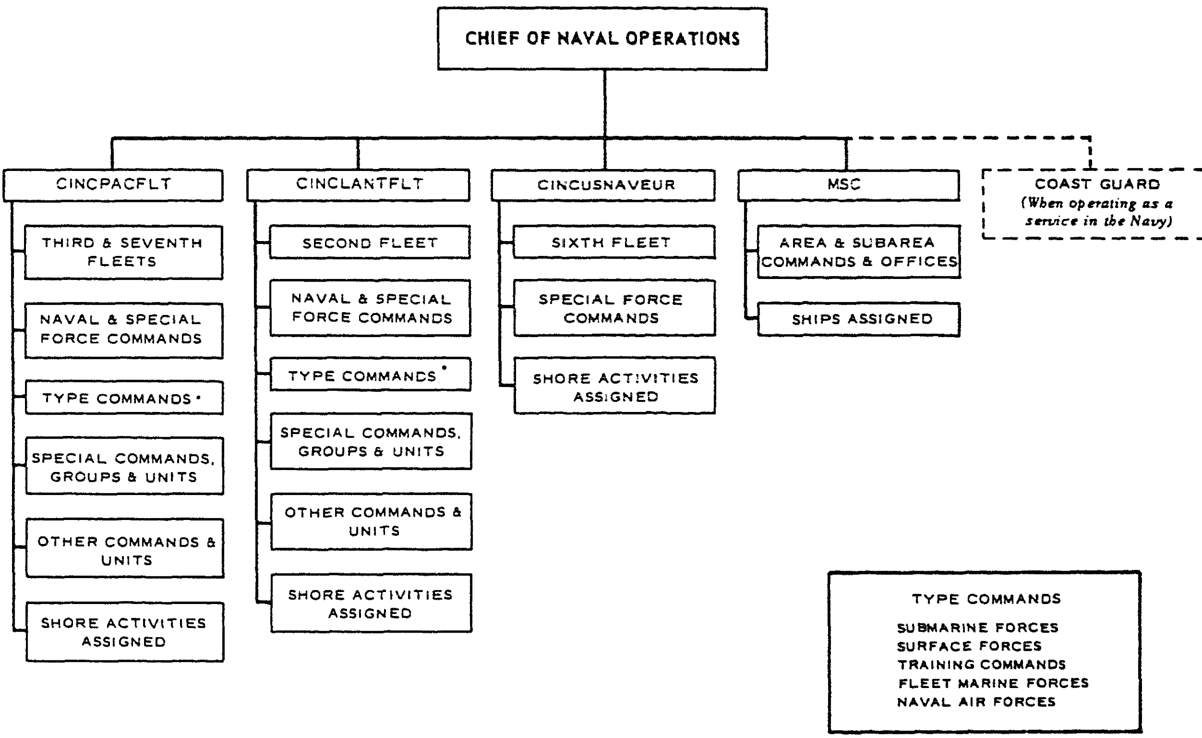
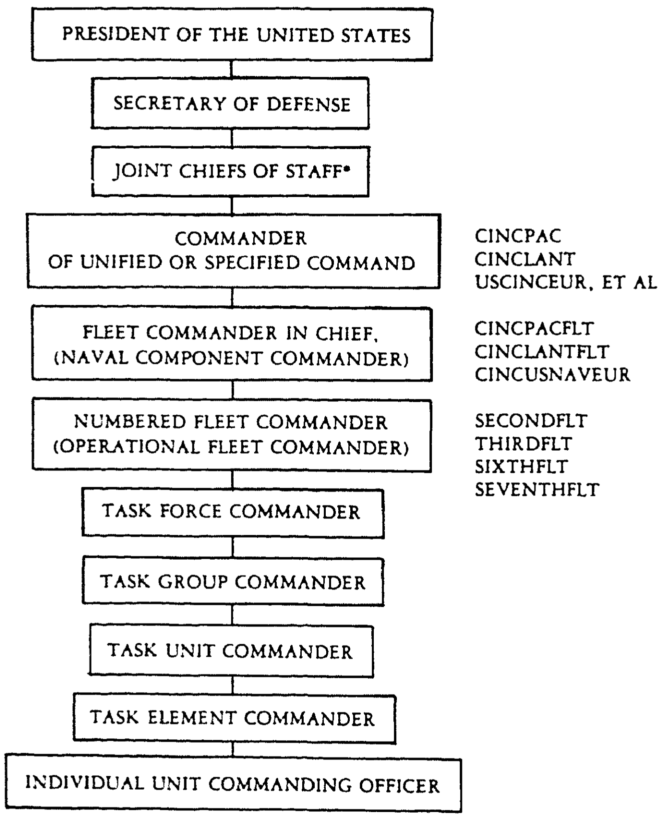


Figure 5-3.—Operating forces of the Navy.

duties. A commander of a major task force would require a staff larger than could be accommodated afloat if he were to perform extensive administrative functions and all logistic planning for units under his command, as well as plan and execute the operation for which the organization was formed. In wartime, seagoing commanders and their staff cannot be expected to perform all their normal administrative functions because units are constantly being detached for separate operations and because of radio silence and other restrictions. The type commanders, therefore, must be prepared to undertake additional administrative duties for their units, even when those units are detached for distant duty in a task organization.

The unified command assignment of naval operating forces is shown in figure 5-4. From the chart it can be seen that essentially all USN combatant ships, combat support ships, and aircraft units are normally assigned and under the operational control of a component commander of a unified command. Among the exceptions are special mission ships assigned to research and development projects, Naval Reserve training ships (NRTS), and units performing special mission directly under the operational command of CNO.

1. Under the present law, the military operational command authority of the Chief of Naval Operations has been deemphasized; however, as a member of the JCS, CNO participates in the command functions of Scretary of Defense. Naval forces assigned to the unified commands are not subject to the personal operational command of the Chief of Naval Operations in that capacity. Forces not assigned to the unified commanders are commanded by the CNO and Commandant of the Marine Corps in whatever context the Secretary of the Navy determines. To the extent, therefore, that the SECNAV assigns to the CNO



*The JCS are in the operational chain of command as advisors and as military staff with respect to the unified and specified commands; however, the JCS do not exercise operational command or control of forces, except as directed by the President or Secretary of Defense

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Figure 5-4.—Operational chain of command.

and CMC the authority over those forces not assigned to the unified commands, complete command authority lies with the Chief of Naval Operations and the CMC.

2. Using a destroyer (DD) as an example, the administrative command echelons for forces afloat are as follows:

a. Destroyer. Commanded by a commander.

b. Squadron. Six to eight destroyers, which are commanded by a captain.

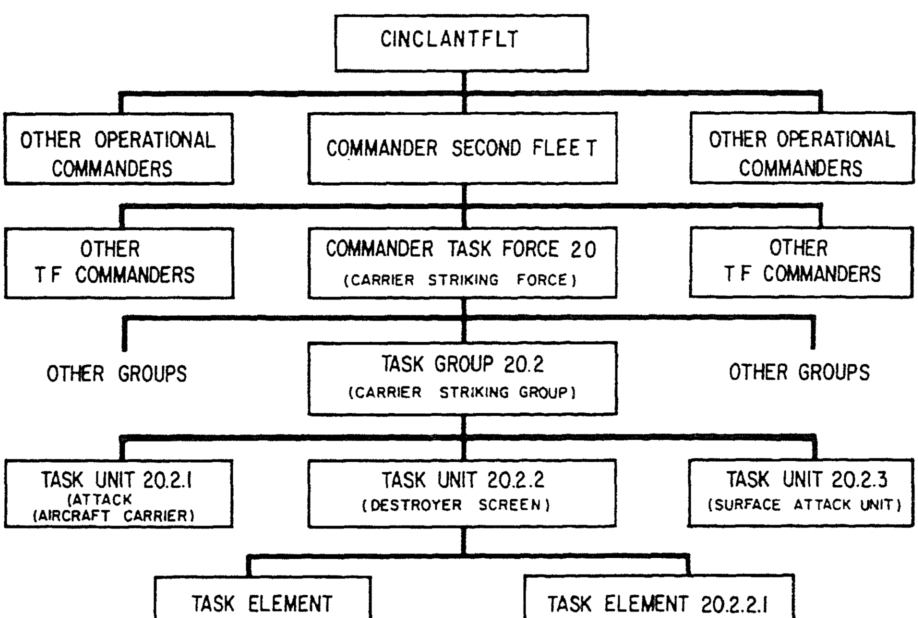
c. Group. Three to four squadrons, which are commanded by a rear admiral.

d. Type commander. Commander, Surface Force, Atlantic or Pacific, and commanded by a vice admiral.

3. Normally, operational command of ships is exercised through the task force, task group, or task unit system of tactical organization. To illustrate, the Sixth Fleet is composed of several task forces; Task Force 60 is the Attack Carrier Striking Force, which includes 1 or more attack carriers (CV), 1 or more cruisers (CG), and up to 20 destroyer type ships (DD). Task Force 61 is the Amphibious Task Force; Task Force 62, the Landing Force (one USMC Marine Amphibious Unit reinforced); Task Force 63, the Service Force; Task Force 66, the Antisubmarine Force; and so forth. As in TF 60, various types of ships are assigned to these forces commensurate with missions and tasks.

4. Under task forces are task groups. There may be up to nine task groups under a task force commander; for example, TG60.1 through TG60.9. Task Group 60.1 might be composed of one CV, one CG, and six DD. With the task group, several task units may be formed depending on the tasks or missions to be accomplished. For example, Task Unit 60.1.1 could be composed of one CV and four DD as a carrier striking unit. Task Unit 60.1.2 could be composed of one CG and four DD as a surface action unit. Within a fleet, the task force (group or unit) commander is normally the senior officer in command. For example, in the Sixth Fleet, Commander, Task Force 60, the Attack Carrier Striking Force Commander is normally the senior carrier group commander (a rear admiral).

5. The partial task organization of the Atlantic Fleet is shown on figure 5-5. The task force, task group, and task unit method provides the Commander in Chief, Atlantic Fleet, maximum flexiblity in providing an optimum ship "mix" for any task, mission, or combination thereof, assigned. Most type commanders also have task force designators. They exercise operational control over their units from time



to time when these units are not otherwise assigned. They are also delegated supporting tasks by the fleet commander.

6. At this point it is appropriate to examine the multiplicity of commands to which a ship may report, and demonstrate the flexibility provided the fleet commander. For example, an Atlantic Fleet destroyer is administratively a part of the type command, Surface Force Atlantic Fleet. At the same time, the DD will have a war alert assignment with the Second Fleet, or one of the other operational commanders. These assignments are kept current at all times so that any particular ship knows exactly to whom it is assigned and its specific rendezvous instructions. Drill alerts are held at unannounced times to test the readiness of all units to respond to emergencies.

7. The Naval Communications System and task organization communication nets ensure effective operation of seagoing forces to the extent that ships can be assigned simultaneously to several commanders under varying degrees of control. At sea, a ship guards circuits assigned by its current operational commander in the communication plan under which the ship is operating. Through a common fleet communications net, the DD may be directed in a matter of minutes to report to a preplanned commander, or a new commander, and to come up on special circuits (or command nets) being activated. Thus, the multiple, administrative, operational command network of ships is effectively joined, providing maximum flexibility with simplicity.

SHIPBOARD ORGANIZATION

A warship's manning is composed of such numbers, grades, and ratings of officers and enlisted personnel as are necessary to fight the ship most efficiently. The ship's organization is essentially a war organization, developed on the theory that ships should operate in peacetime with an organization that can be expanded quickly without basic change when the transition to a wartime operating condition becomes necessary. It is based on a grouping of functions and personnel that is intended to reduce to a minimum both the possible overlapping of responsibility within the command and the duplication of personnel.

ADMINISTRATIVE ORGANIZATION

The basic shipboard departments are navigation, operations, weapons (or deck), engineering, and supply. There may be a number of others, however, as can be seen in figure 5-6.

In preparing ships' organizations, type commanders allow for missions and other considerations peculiar to the type and also the quality and quantity of personnel available. Administrative and battle organizations prepared by corresponding type commanders in different fleets are coordinated through their fleet commanders and are made similar for the same types and classes of ships. In general, the organization described in this chapter is that of a large fighting ship.

COMMANDING OFFICER

The responsibility of the commanding officer for his command is absolute, except when he is relieved by competent authority. His authority is commensurate with his responsibility, subject to the limitations prescribed by law and regulations. While he may delegate authority to his subordinates for the execution of details, such delegation of authority in no way relieves the commanding officer of his continued responsibility for the safety and efficiency of his entire command.

In the discharge of his duties, the commanding officer is assisted by the executive officer, who acts as his direct representative.

The commanding officer must exert every effort to maintain his command in a state of maximum effectiveness for war service consistent with the required degree of readiness. He issues the necessary directions to his executive officer, who, in turn, with the assistance of the various department heads, prepares and conducts exercises and drills required to bring about the necessary proficiency.

The details of training and education of the ship's company are responsibilities that the commanding officer delegates to his executive officer. All ships must have an organized program for shipboard training.

During action, the commanding officer is required to engage the enemy and fight to the best of his ability. He must not disengage until the action is complete.

The commanding officer's battle station is that station from which he can fight the ship to best advantage. In case of the loss of his ship, both

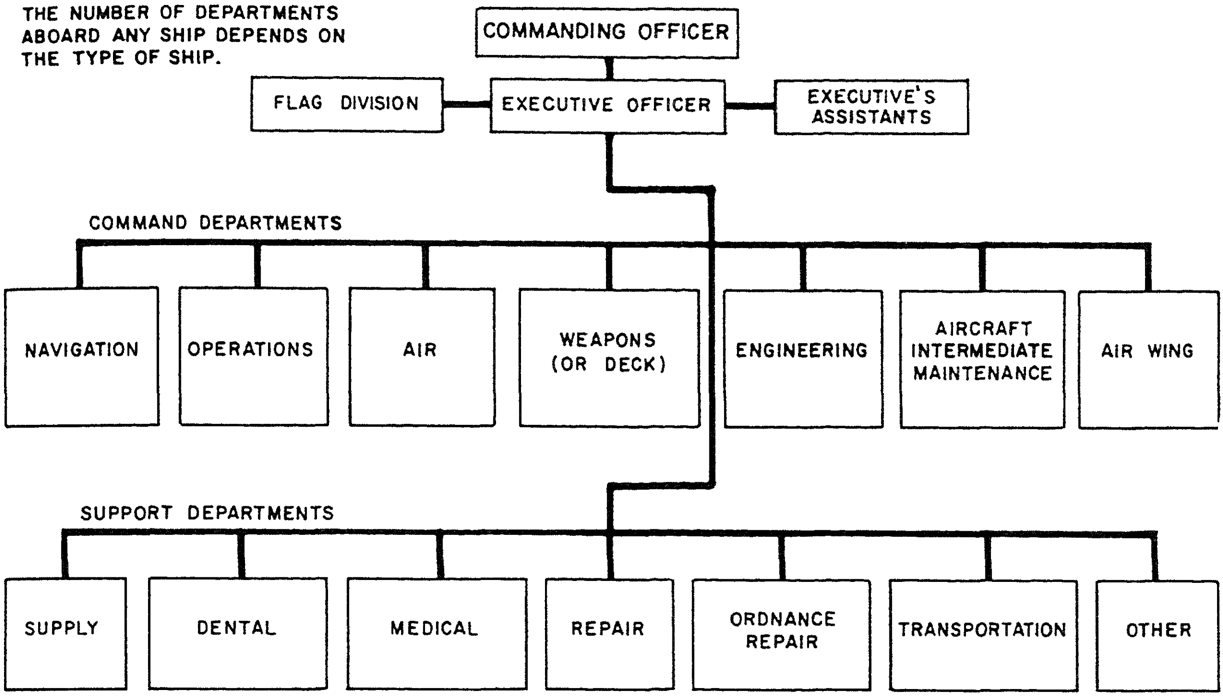


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Figure 5-6.—Ship organization.

custom and regulations require that the commanding officer assure that abandon ship procedures are completed and all personnel are off the ship before he leaves.

The commanding officer supervises the conduct of all persons under his command. Should he not suppress unlawful activities or conduct, he is subject to trial by court-martial. In the investigation of offenses and the assignment of punishments, he cannot delegate his authority. He is required to have specified articles of the Uniform Code of Military Justice published to the crew at stated intervals.

The commanding officer's position is quasi-judicial. It is, in fact, legislative, judicial, and executive. His power is authoritarian and complete and has been so from time immemorial. He has ultimate responsibility for the ship and everything pertaining to the ship. Obviously, that great responsibility requires commensurate authority. It is essential to efficiency and discipline that a commanding officer have the power to enforce prompt obedience to his orders. By the Uniform Code of Military Justice, the power is vested in the commanding officer to impose limited punishment. This power is an attribute of command and may not be delegated to a subordinate.

The welfare, morale, and living conditions of the crew are a commanding officer's constant concern. To assist him in these matters, he appoints a master chief petty officer of the command (MCPOC) as an enlisted advisor. The medical officer assists him in maintaining the ship in a sanitary condition and provides for proper care and isolation in the case of infectious diseases.

If the officer regularly ordered to command the ship is absent, relieved from duty, or detached without relief, the command devolves upon the line officer next in grade who is regularly attached to and on board the ship, and who is eligible for command at sea.

EXECUTIVE OFFICER

The executive officer functions as an aide or executive to the commanding officer. He is detailed as such by the Chief of Naval Personnel. As the next ranking officer aboard ship, he is the direct representative of the commanding officer in maintaining the military and general efficiency

the ship. The executive officer has no authority dependent of the commanding officer, and the tails of his duties are regarded as execution of e captain's orders. All heads of departments and her officers and enlisted personnel are under the ecutive officer's orders in all matters pertaining operation and maintenance of the ship and to e preservation of order and discipline on board.

Under the commanding officer, the executive ficer is responsible for the ship's administration, utine, and efficiency as follows:

1. Coordination and supervision of all departments
2. Maintenance of morale, welfare, and discipline
3. Assignment of personnel and maintenance of their records
4. Preparation and maintenance of ship's bills and orders
5. Supervision and coordination of work, exercises, training, and education
6. Supervision of loading and berthing plans
7. Supervision of ship's correspondence

With the assistance of department heads, the ecutive officer arranges and coordinates all ip's work, drills and exercises, the personnel ganization, policing of the ship, and inspections the ship. He is charged with the maintenance d cleanliness, good order, and the trim pearance of ship and crew.

The executive officer keeps in close touch with activities of the ship and supervises department ads in the performance of their duties, including e instruction of junior officers.

The executive officer is responsible for the curacy of entries made in the crew's service cords. He investigates, or causes to be instigated, matters involving conduct and eaches of discipline; and he usually approves d disapproves all liberty lists and leave requests.

He exercises general supervision whenever all nds are called for any particular duty, exercise, evolution, except during action. Except on all ships, he is not required to stand a watch; t he may relieve the officer of the deck for short riods as a matter of accommodation or enever required for the safety of the ship.

If the executive officer is incapacitated or herwise unable to carry on, his duties are rmally assumed by the next senior officer of e line assigned to the ship.

from the various departments, and, in turn, reports to the commanding officer that the ship is, in all respects, ready. In case the captain is incapacitated, the executive officer becomes the acting commanding officer. For this reason his battle station, determined by the captain, is preferably located some distance from the captain's—a safety measure to prevent simultaneous disablement of both officers. It is usually in the secondary ship control station, and from there he maintains communication with the primary control station. After battle, the executive officer makes a detailed report to the commanding officer, citing all details of the action observed, together with a statement of the conduct of subordinates in praise or censure as the case may be.

The standard organization and regulations manual shows the personnel that may be assigned under the executive officer to assist him in the performance of varied duties. The size of the executive's organization depends on the size of the ship and the number of officers available for assignment to those duties.

HEADS OF DEPARTMENTS

The number of departments included in a shipboard organization depends on the type of ship for which the organization is prepared. As seen in figure 5-6, departments are grouped together as either command or support departments. Except in isolated instances, an officer heading a command department is a line officer eligible to exercise command in the event of the loss of his superior officers. In aircraft carriers, the operations and air departments are headed by naval aviators.

The head of a department is the representative of the commanding officer in all matters that pertain to the department. All persons assigned to the department are subordinate to him, and all orders issued by him are obeyed accordingly. In the performance of his duties as a head of department, he conforms to the policies and complies with the orders of the commanding officer. Department heads have certain common duties and responsibilities.

A department head reports to the commanding officer for the operational readiness of his department, the general condition of his equipment, and any other matters relating to his department

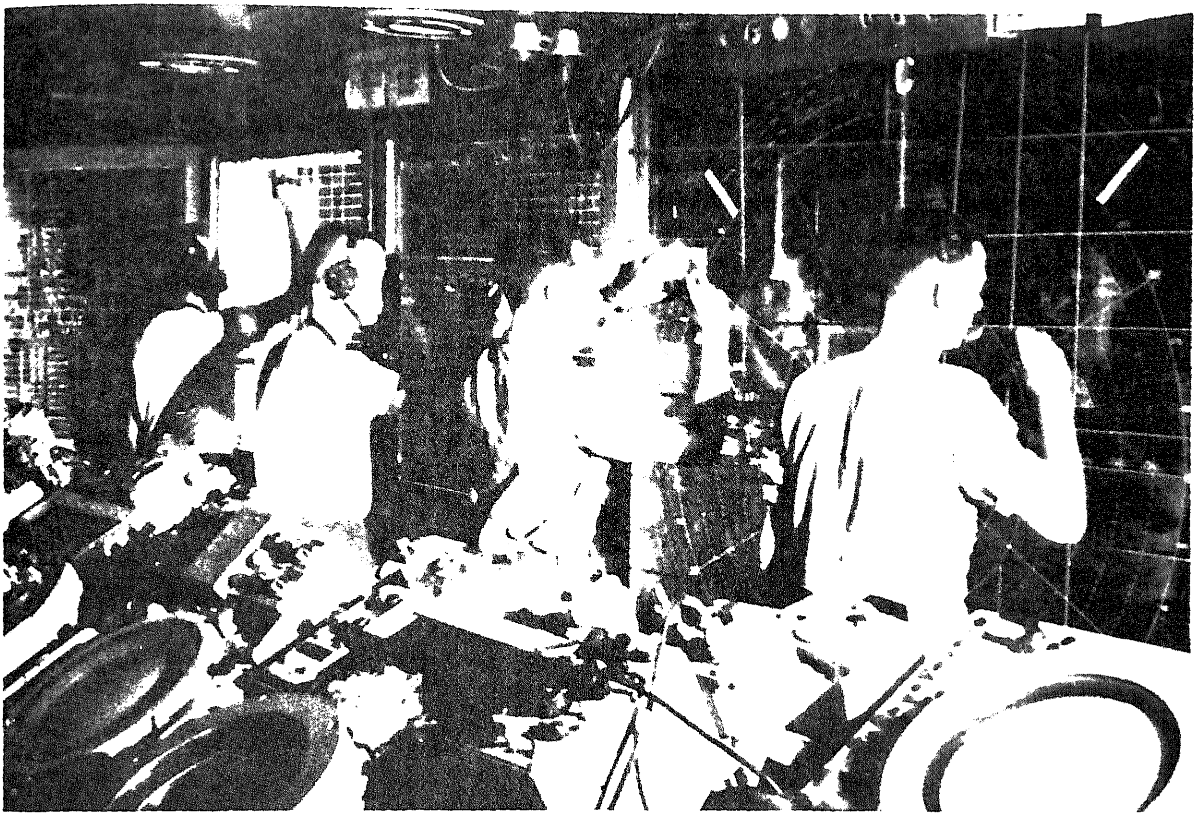

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Figure 5-7.—Personnel assist the combat information center officer, who is responsible to the operations officer, by manning a plotting board (right) and status boards.

matters and keeps the executive officer informed of reports made to the commanding officer.

The department head's duties and responsibilities cover a broad area. He assigns personnel to stations and duties within the department and organizes and trains his personnel to ensure readiness for battle. He is responsible for the proper operation, care, preservation, and maintenance of his department's equipment as well as the cleanliness and upkeep of spaces assigned. He frequently inspects both personnel and equipment and takes action to correct any laxity or malfunction.

The department head prepares bills and orders for the organization and operation of the department. He controls the funds allotted, and he is expected to be economical in their use. He must anticipate personnel and material needs and submit timely requests to fulfill requirements. Records must be kept and reports submitted by every department to ensure an efficient overall organization. It is the department head's duty to see that these matters are not neglected. Also, he is expected to cooperate with other department heads so that the work of his department may be smoothly coordinated with that of the other departments.

In small commands, an officer may be assigned as head of more than one department.

Heads of departments and their principal assistant are assigned battle stations where they can best supervise and control the performance of duties regularly prescribed for them, or such specific battle duties as the commanding officer may assign.

Operations Officer

The operations officer is responsible, under the commanding officer, for the collection, evaluation, and dissemination of combat and operational information (fig. 5-7) and for all other assigned matters related to operations of the ship and designated airborne aircraft.

Specific functions of the operations department include the following:

1. Conduct of surface and air search.
2. Execution of electronic warfare.
3. Control of aircraft when airborne, except when this control is assigned to other authority.
4. Collection, display, analysis, and dissemination of intelligence information.
5. Preparation of operation plans and training schedules.
6. Conduct of underwater search and torpedo detection except on ships with antisubmarine armament installed.
7. Maintenance and repair of all electronic equipment of the ship except as assigned to another department.
8. Collection, interpretation, and dissemination of meteorological information.
9. In ships not having a communication department, the functions of that department.

In addition to the normal departmental administrative and training assistants, the operations officer may be assisted by the the following:

1. Air operations officer
2. Air intelligence officer
3. Intelligence officer
4. Meteorological officer
5. Combat information center officer
6. Communication officer (when not a department head)
7. Electronic material officer
8. Electronic warfare officer
9. Photographic officer
10. Strike operations officer

Communications Officer

In most ships, the communications officer is a division officer in the operations department. In some large ships, however, such as major

158.30

Figure 5-8.—The communications officer, while he need by no means be a technician, is expected to acquire at least a fundamental knowledge of the technical aspects of shipboard communication equipment.

communications relay ships and aircraft carriers, he is a department head responsible directly to the commanding officer.

Whatever his administrative position, the communications officer is responsible for all visual and electronic exterior communications and communication equipment, and for administration of associated internal systems. He is responsible for the proper internal delivery of incoming messages and for the routing and delivery of outgoing messages. He must be thoroughly familiar with current tactical and communication publications. He is directly in charge of communications watch and signal officers, conducting their training and supervising their watchstanding. He should have at least a fundamental knowledge of the technical aspects of communication equipment (fig. 5-8). He supervises the handling of Communications Material Security (CMS) System publications issued to the ship and is responsible for secure and efficient cryptographic operations, including the supervision and training of crypto-operators.

The following officers, when assigned, report to the communications officer: radio officer, signal officer, CMS publications custodian, cryptosecurity officer, and traffic officer (message center).

Navigator

The navigator is directly responsible to the commanding officer for safe navigation of the ship (although on small ships the navigation department is integrated into the operations department). The duties of the navigator are discussed in the following paragraphs.

The navigator advises the commanding officer and the officer of the deck as to the ship's movements and, if the ship is running into danger, as to a safe course to be steered. To carry out this phase of his responsibilities, he must maintain an accurate plot of the ship's position (fig. 5-9) by

134.69

Figure 5-9.—Plotting a course in the chartroom. The navigator, who is responsible to the commanding officer for safe

astronomical, visual, electronic, or other appropriate means; study all available sources of information, before entering pilot waters, regarding navigation of the ship in such waters; and give careful attention to the course of the ship and the depth of water when approaching land or shoals. He maintains records of all observations and computations made for the purpose of navigating the ship; reports the ship's position at such times as the commanding officer may request; and procures and keeps corrected and up-to-date all hydrographic and navigational charts, sailing directions, light lists, and other publications and devices for navigation as may be required.

The navigator is responsible for operation, care, and maintenance of the navigational equipment. To this end he is required to determine daily, when the ship is underway and weather conditions permit, the error of the gyro and standard compasses. He reports the result in writing to the commanding officer. He compensates the magnetic compasses and prepares tables of deviations, copies of which are posted at the appropriate compass stations. He is responsible for the accuracy of the ship's chronometers and clocks. He ensures that electronic navigational equipment used by him is kept in proper adjustment and that calibration curves or tables are maintained and checked at prescribed intervals.

The navigator is responsible for the care and proper operation of the steering gear in general (except the steering engines and steering motors).

Daily, and more often if necessary, he inspects the deck log to ensure that it is properly maintained. He prepares such reports and records as are necessary in connection with his navigational duties, including those pertaining to the compasses, hydrography, oceanography, and meteorology.

It is also the navigator's responsibility to ensure the required navigational training of all personnel such as junior officers, boat coxswains, and boat officers. In addition, he is charged with the training of all quarterdeck personnel with respect to honors and ceremonies. Operations and navigation are combined on small ships and submarines.

Weapons Officer (or First Lieutenant)

All ships have either a weapons or a deck department, with the exception of aircraft carriers (CVs) which have both.

Ships (other than CVs) mainly concerned with offense through ordnance or aircraft have a weapons department headed by a weapons officer, whose responsibilities also embrace those relating to deck seamanship. In such case, the weapons officer is assisted by the first lieutenant. Other ships have a deck department headed by the first lieutenant, who is assisted by the weapons officer. In small ships, the duties of the two billets may be combined.

Organized aviation units regularly attached to and embarked in a ship not having an air department are assigned to the weapons department and make up the aviation division; these units retain their basic organization even when so assigned. An embarked Marine detachment is usually assigned to the weapons or deck department.

The weapons officer is responsible for the operation and maintenance of the ship's armament and fire control equipment; the stowage and care of ammunition including magazines and sprinkler systems; the planning and directing of seamanship evolutions through the first lieutenant; and the care of the ship's exterior except those areas assigned to another department.

The following officers may assist the weapons officer or first lieutenant (bearing in mind that, except in CVs, the first lieutenant is always an assistant to the weapons officer and vice versa):

1. Gunnery officer
2. Missile officer
3. Ordnance officer
4. Antisubmarine warfare officer
5. Fire control officer
6. Torpedo officer
7. Nuclear weapons officer
8. Commanding officer, Marine detachment
9. Senior aviator (in ships not having an air department)
10. Ship's boatswain

Engineer Officer

The functions of operation and maintenance of ship's machinery are assigned to the engineering department. Damage control and certain types of repair also are in the charge of various divisions of the department. Such divisions may be the auxiliary, repair, boiler, main engines, and electrical.

The head of the engineering department is designated the engineer officer. He is responsible, under the captain, for operation, care, and

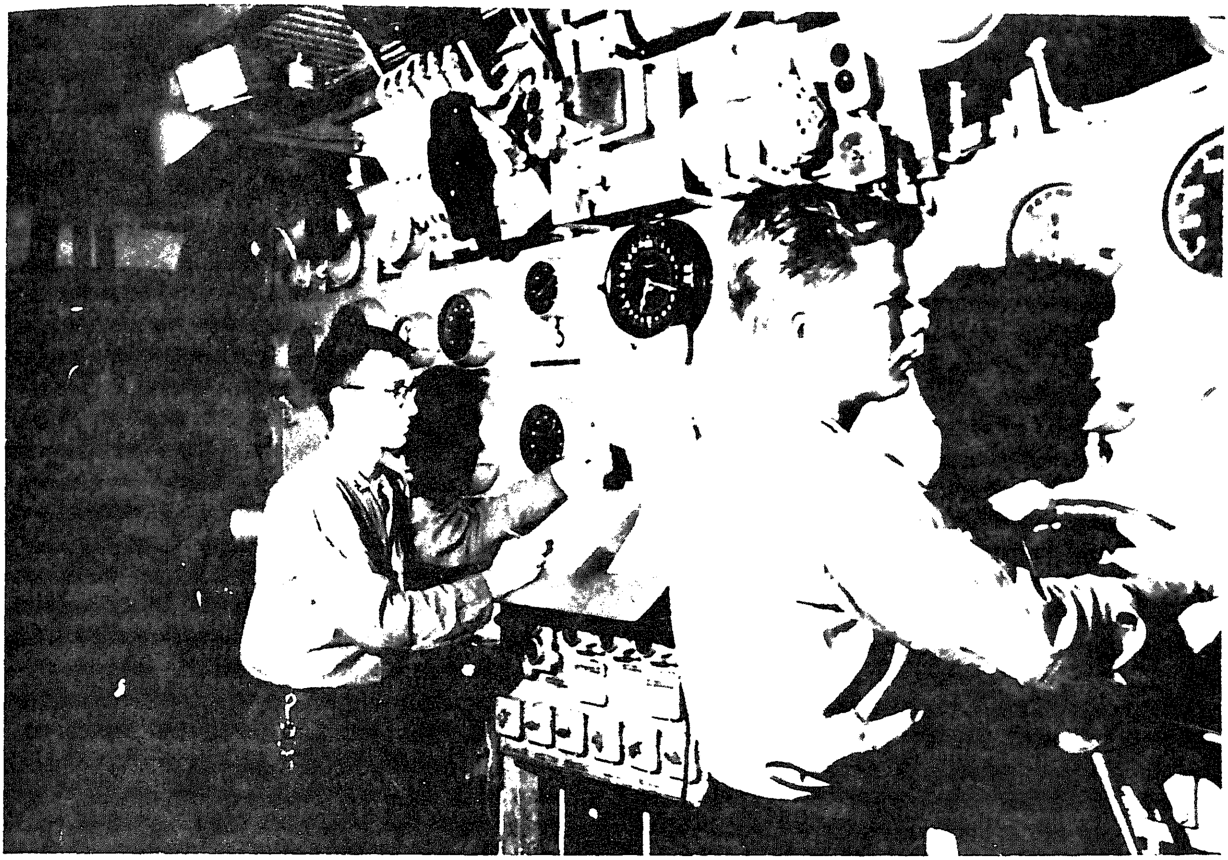

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Figure 5-10.—Engines may not be turned or speed altered unless directed or permitted by the officer of the deck. To increase speed, the throttleman (right) opens the throttle to admit more steam to the ahead turbines.

maintenance of all propulsion and auxiliary machinery; for control of damage; and for operation and maintenance of electric power generators and distribution systems. When requested by the head of a department, the engineer officer is responsible for accomplishment of repairs that are beyond the capacity of repair personnel or equipment of other departments.

Specifically, he is charged with the operation, care, and maintenance of all machinery, piping systems, and electrical devices not otherwise assigned; repairs to hull and machinery; furnishing of power, light, ventilation, heat, refrigeration, compressed air, and water; maintenance of underwater fittings; and the stowage, care, and use of fuels and lubricants not assigned to other departments.

In connection with the ship's main propulsion and auxillary machinery, the engineer officer is responsible for effective operation of main engines and boilers, particularly when unusual care is required, such as when getting underway or during critical speed changes. He ensures that boiler fires are not lighted or secured without permission from the captain (except in emergencies), and that main engines are not turned (fig. 5-10) except in obedience to a signal from or by permission of the officer of the deck. He maintains the engineering log, engineer's bell book, and other engineering records.

As damage control officer, the engineer officer establishes and maintains an effective damage control organization, with his responsibilities extending to the control of stability, list, and trim. He acts as technical assistant to the executive officer in carrying out nuclear, biological, and chemical defense procedures. He supervises placing the ship in the condition of watertight and airtight closure ordered by the captain, and coordinating prescribed tests of compartments and spaces for tightness. The engineer officer is responsible for training ship's personnel in damage control, including

associated instruction in nonmedical defensive measures against gas and similar weapons.

Assigned to the engineer officer may be a main propulsion assistant, a damage control assistant, an electrical officer, a fire marshal, and special assistants for NBC defense.

Reactor Officer

In nuclear-powered ships having a reactor department, the department is headed by the reactor officer, whose basic function is the operation, care, and safety of the reactor plants and associated auxiliaries. He must maintain them in a maximum state of readiness at all times.

The reactor officer is a technical assistant to the commanding officer on matters involving reactor safety. He supervises disposal of radioactive wastes originated in the reactor plants. He is responsible for operation of main engine throttles and maintains the engineer's bell book. He exercises close coordination and cooperation with the engineer officer in the operation and maintenance of the propulsion plant. In this regard, the reactor officer and his assistants are responsible, as prescribed in their specific duties, for some duties normally prescribed for the engineer officer and his assistants on nuclear-powered ships not having a reactor department.

When assigned, the reactor mechanical assistant and reactor control assistant report to the reactor officer.

Air Officer

In ships that have an air department, the head of that department is the air officer. Under the commanding officer, he supervises and directs launching and landing operations and the servicing and handling of aircraft. He is responsible for crash salvage operations and aircraft fire fighting as appropriate; operation, care, and maintenance of aircraft handling equipment such as elevators, catapults, and arresting gear; and the care, stowage, and issue of aviation fuels and lubricants.

Assistants to the air officer may include flight deck, catapult, arresting gear, hangar deck, aviation fuels, and aircraft handling officers.

Supply Officer

The supply officer, who heads the supply department, is responsible for procuring, receiving, storing, issuing, shipping, selling, transferring, accounting for, and while in his custody, maintaining all stores and equipment of the command except those assigned to other departments.

Specific functions of the supply department include the receipt, delivery, and shipment of medical and dental supplies and equipment; inspection of material received under orders and contracts that call for inspection and delivery; operation of the general mess, including the preparation and service of food, operation of the ship's store, which furnishes articles and services for the ship's crew; operation of the small stores unit, which makes available, for sale, standard uniform items; and upkeep of storeroom spaces and issue rooms.

The supply officer's accounting duties include allotment, cost, appropriation, and property accounting. He maintains stock records, posted to date, for all stores for which he is responsible. These records are maintained to establish accountability for stores and to provide stock control information that will facilitate replenishment and enable proper and adequate stocks of material to be maintained.

Assistants to the supply officer may include an assistant for disbursing, a stores officer, a ship's store officer, and a food service officer. A mess deck master-at-arms, when assigned, assists the supply officer in such matters as the maintenance of good order and discipline connected with the general mess, cleanliness of messing compartments, and care and upkeep of messing equipment.

When an assistant for disbursing is assigned, the supply officer is relieved by that officer from responsibility for procurement, custody, transfer, issue of, and accounting for funds. Similarly, if the commanding officer approves the assignment of an assistant for subsistence or the ship's store, the supply officer is relieved by that officer from personal financial accountability for the procurement, receipt, stowage, custody, issue, transfer, maintenance of proper records, accounting for, and submission of returns for subsistence or ship's store material. In each case, however, the supply officer exercises general supervision over and inspects the accounts of the assistants.

DIVISION OFFICERS

The departments of a ship are composed of divisions, which, in turn, are organized into watches and/or sections. The division is the basic

unit of personnel aboard ship. The number of divisions in a department varies between ships, and division complements may be very small or include perhaps 200 members. As far as practicable, divisions are assigned battle stations that permit their employment as units under their own officers and petty officers.

A division officer is assigned by the commanding officer to command a division of the ship's organization. Division officers are responsible to, and, in general, act as assistants to department heads, and they have a vital role in a ship's administrative organization.

MERCHANT SHIP COMPARISON

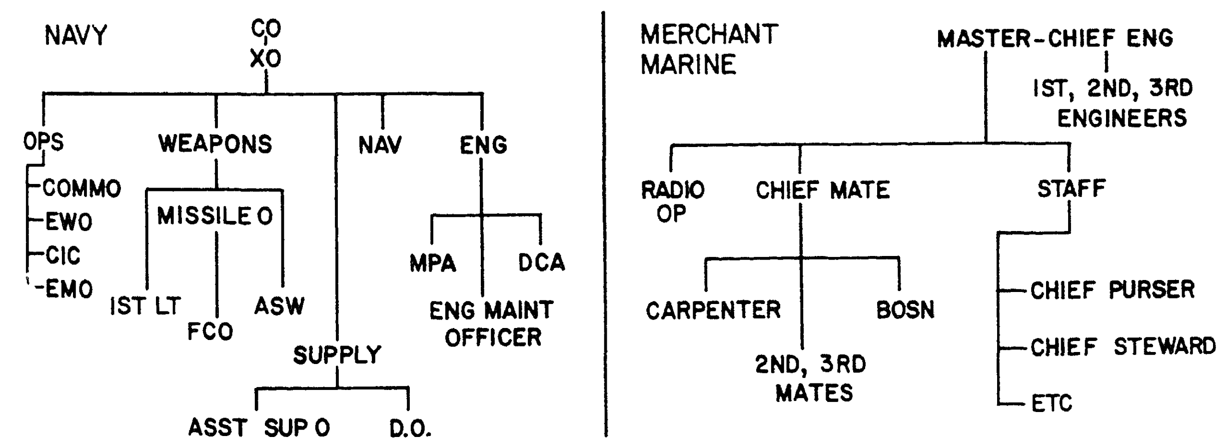
As can be seen in figure 5-11, there are many similarities in the administrative organization of naval and merchant ships. The operations, weapons, engineering and supply departments correspond loosely to the merchant's radio operator, deck department, engineering department, and staff officers. Navigation duties on merchant ships are normally assigned to the second mate.

The most striking difference between the two organizations is the status of the chief engineer. The head of the engineering department aboard the average merchant vessel enjoys a position that is somewhat unique among organizations. As the senior licensed engineer on the vessel, he is directly responsible to the master for the efficient operation of all propulsion machinery, auxiliary machinery, and deck machinery on the vessel, including the spaces that this equipment occupies. It is the chief engineer's relationship to the master that takes on unique hues. As mentioned, the chief engineer is directly responsible to the master, but at no time would the master interfere with the operation of the chief engineer's organization, except as might arise from safety considerations for the ship, or on problems related to personnel. There is a divided aspect to the ship's organization that makes the engineering department almost an independent unit, in certain aspects. The relationship between the master and chief engineer is almost one of professional colleagues, rather than superior and subordinate. Nevertheless, in the final analysis, the chief engineer answers to the master for an effective organization, for efficient operation of all machinery, and for adherence to company policies.

FUNCTIONAL ORGANIZATION

In addition to the administrative organization, a ship needs a functional organization that provides for the proper operation of the ship. A naval ship's functional organization does this, but a special organization is needed to fight the ship under varying battle conditions. The number of people on watch and types of watch stations manned depends on the condition of readiness, which, in turn, is dependent on the expected enemy threat.

There are several conditions of readiness for battle or for simulated war operations. The condition in operation depends on the anticipated danger.



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Condition Watch I: This condition provides maximum state of readiness for battle, with the entire crew at battle stations prepared for imminent action.

Condition Watch IE: This condition provides temporary relaxation from the first degree of readiness, enables personnel to rest on stations, and permits designated personnel to draw and distribute action meals at their action stations.

Condition Watch II: This is a special watch applicable to gunfire support ships for situations such as extended periods of shore bombardment.

Condition Watch III: This is the normal wartime cruising condition when surprise attack is possible. Part of the armament is manned and ready for immediate action.

Condition Watch IV: This condition provides effective ship and aircraft control during peacetime cruising.

Condition Watch V: This condition is for ships in port, no armament manned.

WATCHES AND WATCH OFFICERS

The assignment of officers and enlisted personnel to watches and sections within a division is carried out in a manner that ensures effective manning of the battle stations required to meet the several prescribed conditions of readiness for action. Consideration is given to the fact that the normal watches may be kept and that the force on board at any time is sufficient and organized to care for the safety, operation, and maintenance of the ship.

With the exception of the commanding officer and the executive officer, every officer and every enlisted person aboard is placed in a watch section. The personnel filling the offices and stations of the watch are temporarily removed from their regular stations and duties in the ship's organization so they can devote their entire attention to their watch duties.

A watch officer is placed in charge of a watch or a portion of a watch. The commanding officer assigns to such duty any commissioned or warrant officer whom he considers qualified; he may, when conditions require, assign a petty officer to such duty. The station of an officer in charge of the watch is where he can best perform the duties assigned him, and effectively supervise and control the performance of those on watch under him. He must remain at his station until relieved.

Each watch section is approximately equal in number and in experience and special qualifications of its members. In the past there were normally three sections. CNO directives have allowed a more liberal policy in determining the number of watch sections required.

At sea, watchkeeping rotates among the watches. Each watchkeeping detail normally lasts 4 hours. Those not on watch or at battle stations engage in ship's work, drills, recreation, and rest. Under battle conditions, the ship is at general quarters and all officers and enlisted personnel have assigned battle stations.

In port, after working hours (usually from 1600 to 0800), the watches not having the day's duty may have permission to go on liberty. The sections in the duty watch rotate the watchkeeping details over the 24-hour period. The general practice is to have at least a sixth of the personnel on board at all times, although this practice varies with conditions. A ship in drydock, for example, may not need a sixth of the personnel on board, whereas in port in a battle area, most of the personnel would be required to stay on board.

Officer of the Deck

The officer of the deck (OOD) is the officer on watch in charge of the ship. With the exception of the executive officer (and any officer specifically authorized by the commanding officer, such as the command duty officer or navigator), every person on board who is subject to the orders of the commanding officer is subordinate to the officer of the deck.

The executive officer may direct the OOD in matters pertaining to general duties and safety of the ship. When the captain considers it advisible, he also may delegate to another officer (command duty officer), for a specified watch, the executive officer's duties in connection with the officer of the deck. In addition, the commanding officer may authorize the navigator to relieve the officer of the deck if, in his opinion, such action is necessary to ensure the safety of the ship.

The OOD must have complete knowledge of an follow absolutely the policies of the captain and the executive officer. In no position more that that of officer of the deck is eternal vigilance the price of safety. The comfort and contentment of others must receive his consideration, and he must bear in mind that every request handled is a potential troublemaker if not properly decided. By his bearing, alertness, scrupulous attention to details of duty, and capable manner of discharging authority, the officer of the deck is

a vital factor in furthering the efficiency of the ship. He exerts an important influence upon the personnel.

Underway, the OOD takes a position on the bridge where he may advantageously determine the proper action for the safe handling of the ship. In port, his station is on the quarterdeck.

An officer of the deck is the commanding officer's representative. It takes months of practice and experience to become proficient in the performance of the duties of this position. He should have a sound basis of technical knowledge combined with forehandedness, vigilance, common sense, and experience. He must also have a thorough knowledge of the rules of the road.

He may be assisted by a junior officer of the deck (JOOD), who, in this way, acquires the experience necessary for standing regular watches as OOD.

NAVIGATIONAL RESPONSIBILITIES.—The OOD is charged with responsibility for the ship's safety. When at sea and especially when approaching land or shoal waters, he is required to keep informed of the position of the ship and of all particulars that may be of use in keeping the ship out of danger. He must be able to anticipate danger as well as to take effective measures for avoiding it. During low visibility, or whenever circumstances warrant, he is authorized to assign additional lookouts.

He must see to it that the lights required by law for prevention of collisions are correct as to number, color, and location, and that they are kept burning from sunset to sunrise. These lights must be inspected every half hour.

When the ship is steaming in formation, its assigned station must be maintained. It must be skillfully steered and kept on its course. The navigator advises the OOD of a safe course to be followed. The OOD regards such advice as sufficient authority to change the course. Otherwise, he is not authorized to change either course or speed unless ordered by the commanding officer or unless such action is necessary to comply with maneuvering signals of the officer in tactical command, or to prevent collision or imminent danger. In any instance, he must inform the commanding officer at once of any change made. (Minor changes in course and speed to maintain station, however, need not be referred to the captain.) Further, he is not authorized to make official signals unless the captain orders them or unless they are necessary to warn others in company of immediate danger.

BOATS.—The officer of the deck ensures that boats and crews at all times present a creditable appearance; that boats are handled smartly, properly manned and equipped, and are not loaded beyond their capacity. Crews must observe rules for preventing collisions and regulations pertaining to honors and ceremonies. They must understand how to use the boats and observe pertinent safety precautions.

Other boats or aircraft sighted must be watched so that aid may be sent to them if necessary. The OOD must be informed of any boats or other craft that come alongside or leave the ship. When materials or services arrive that require the knowledge or action of certain officers, the OOD ensures that these officers are promptly notified.

INSPECTIONS.—The officer of the deck has frequent inspections made to ensure the security of the ship. Inspections extend to matters such as watertight integrity and condition of the armament and ground tackle or mooring lines in use. The good order and discipline of the crew must be noted by him. Inspections below decks may be made by the junior officer of the deck.

When in port, coxswains of the lifeboats are required to inspect and report to him at sunset the condition of their boats as to readiness for service. At sea, a similar inspection and report is made to him at the beginning of each watch.

When at anchor the officer of the deck must take proper precautions to detect and prevent dragging.

REPORTS.—On being relieved, the OOD signs the deck log after making certain that the entries for his watch are complete, accurate, and clear.

In matters that bear on the safety of the ship, its personnel, or ships in company, he reports promptly to the captain. Vessels, aircraft, or wrecks detected; land, shoals, rocks, lighthouses, beacons, or buoys sighted; marked changes in barometer, wind, state of the sea; or indications or warning of storms—in shore, all occurrences worthy of the notice of the commanding officer—are reported to him by the officer of the deck.

Personnel aboard are required to report to the OOD any occurrence or condition that may in any way affect the safety of the ship, or that should be included in the record for his watch.

MISCELLANEOUS DUTIES.—At various times the officer of the deck may function as an alert policeman or as a gracious host. The personnel performing their assigned duties about the ship are constantly under his observation, for he is responsible for prompt and precise execution of the ship's established routine and of any special orders. He must see that the personnel observe all pertinent safety precautions, especially in heavy weather and when they are working aloft or over the side. When personnel are handling explosives or other dangerous materials, their safety is his responsibility. He must ensure that, if the cry, "man overboard!" is heard, the means for rescue are ready for instant use.

He is required to take measures for preventing personnel from bringing aboard unauthorized articles. He sees that no articles are taken from the ship without requisite permission. Personnel over whom he has authority report to him or to his representative on leaving or returning to the ship. On leaving, they must report authority to do so.

All persons coming aboard or alongside must be treated courteously. Unless prevented by urgent duty, the officer of the deck is expected to be at the gangway to receive all officers or distinguished visitors. When they leave, he accompanies them to the side. When salutes, honors, and ceremonies are in order, the officer of the deck sees that they are properly performed.

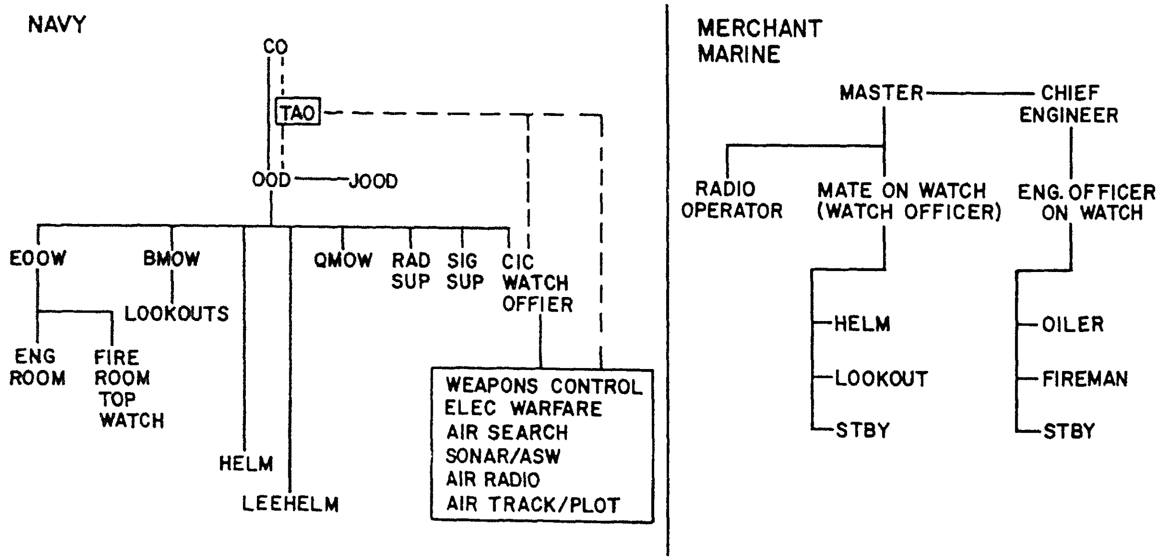
Tactical Action Officer

The tactical action officer (TAO), when assigned, is the commanding officer's representative in all matters concerning the tactical employment and defense of the unit. He is normally assigned during Condition Watches I, II, and III and is responsible for the operation of the combat systems. When authorized by the commanding officer, the TAO may direct the officer of the deck as necessary to facilitate the engagement of hostile forces. The OOD will always follow these directions except when the maneuver might endanger the ship.

Engineering Officer of the Watch

The engineering officer of the watch is the officer on watch in charge of the ship's main propulsion plant and of associated auxiliaries. He ensures that the engineering log, the engineer's bell book, and the prescribed operating records are properly kept, and that all orders received from the officer of the deck are promptly and properly executed.

He may be directed in the duties of the watch by the engineer officer or the main propulsion assistant, either of whom may assume charge of the watch if they consider such action necessary. The engineering officer of the watch reports to the officer of the deck and to the engineer officer



any defects of machinery, boiler, or auxiliaries that may affect the proper operation of the ship. He makes frequent inspections of engines and boilers and sees that all relevant safety precautions are observed. When relieved, he signs the engineering log and the engineer's bell book for his watch.

MERCHANT SHIP COMPARISON

In examining naval and merchant ship watch organizations (fig. 5-12), it is again apparent there are many similarities along with a few striking differences.

Any ship at sea is going to need certain control stations manned, such as the bridge and engine room. Both merchant and naval vessels do this, however, many more people are involved on a Navy ship. This difference is due to their respective missions. A naval ship must have sufficient personnel to man weapon systems, repair combat damage, maneuver in formation, and communicate with other naval units. The owners of a merchant ship are interested in minimizing costs by putting as few people on board their ships as possible. This can be done because a merchant vessel is simply trying to carry as much cargo as possible in the shortest amount of time to earn a profit for the owners. They do not have to control fighter aircraft, hunt for nuclear submarines or maintain a myriad of sophisticated, electronic equipment while at sea for extended periods of time.

The other major difference in watch organization revolves, once again, around the special status of the merchant engineering department. As was explained above, the naval engineering officer of the watch is responsible to the officer of the deck for the operation of the propulsion plant. As figure 5-12 illustrates, the merchant engineering officer on watch reports not to the deck watch officer but to the chief engineer.

While the naval organization might seem unusual to a merchant officer, it must be remembered that the Navy makes no distinction between deck and engineering officers. In fact, underway, the officer of the deck may very well be the chief engineer or one of his assistants. All naval line officers are required to be intimately familiar with their ship's engineering plant. This enables them to properly supervise the engineering officer of the watch.

COMPONENTS AND SUPPORTING ELEMENTS OF THE NAVY

Various components are essential to the Navy in the performance of its mission. Some of these are discussed in this chapter, as are such supporting elements as the U.S. Coast Guard, which becomes part of the Navy in time of war. The U.S. merchant marine also becomes part of the Navy in time of war. Other components, such as U.S. Marine Corps and the Naval Reserve, are discussed in other chapters.

CIVIL ENGINEER CORPS

Officers of the Civil Engineer Corps (CEC), who administer the work of the Naval Facilities Engineering Command (NAVFACENGCOM), are commissioned naval officers having special technical qualifications. They are engineers, planners, estimators, analysts of the Navy's shore facilities, and overseers of the construction and maintenance of the shore establishment. Additionally, they command the field forces that construct advance bases for support of Marine and Navy contingency operations.

The Commander, Naval Facilities Engineering Command is also the Chief of Civil Engineers (that is, the head of the Corps). He exercises technical direction over the NAVAL CONSTRUCTION FORCES (NCF), generally known as the Seabees. NAVFACENGCOM also has support responsibility of commands and organizations (such as construction battalion centers) established as separate activities of the Department of the Navy, whose primary function is the organizing and equipping of the NCF.

The World War II job of NAVFACENGCOM (then the Bureau of Yards and Docks) as an administrative component and of the CEC as an operational force was tremendous. Fueling and docking facilities had to be established; food and equipment depots were needed to handle supplies for the combat areas; hospitals were necessary to receive the wounded and sick; and repair facilities for ships had to be equipped and ready for instant action. Most pressing of all was the need for airstrips.

Many CEC officers supervised the specialized work of Seabee maintenance units that took over maintenance of advanced bases, thereby releasing construction battalions for participation in new landings; some were in charge of pontoon detachments, smoke generation units,

malaria-control units and underwater demolition teams.

An outstanding example of World War II NAVFACENGCOM accomplishments was the floating drydock program. The few floating drydocks constructed before the outbreak of war were designed for use in quiet harbors where outside facilities existed for power and crew accommodations. This war, however, involved naval warfare on a scale previously unknown, and it became imperative that a way be found to repair ships thousands of miles from home ports. To this end, the civil engineers prepared radically new designs for a fleet of floating drydocks that could repair ships close to the scene of battle, making it possible for damaged ships to return quickly to the fight.

The designs included docks that carried their own power machinery and crew quarters, docks with ship-like hulls for fast towing, and, most important, docks of a size that could handle the largest ships afloat. Originally, it was planned to build a single-unit dock capable of cradling a battleship. Because such a structure could have been sunk by a single torpedo, the plan was abandoned in favor of a dock built in sections that could be towed to an advance base and welded together into a single dock, as in figure 5-13.

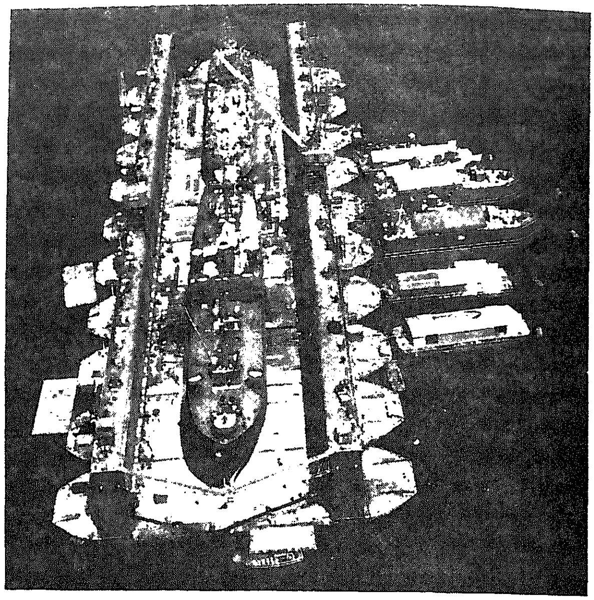


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Figure 5-13.—CEC-conceived sectional drydocks made it possible to repair the largest ships close to the scene of battle.

Called the advanced base sectional dock (ABSD), the structure consisted of ten sections that were interchangeable, so that, if hit, a damaged section could be cradled in the other sections and repaired.

During the last year of World War II, the 150 war-built floating drydocks serviced 7,000 ships in combat areas.

Equally, or even more spectacular, was the development of the Navy pontoon, the famed "magic boxes" of World War II. The concept came from a cigar-box model made by a CEC captain. Pontoon causeways, beached from shipside while underway, enabled Allied forces to bridge the shallow waters along the southern coast of Sicily—to the surprise of the Germans, who had considered those waters a natural barrier. Some 10,000 Army vehicles rolled from ship to shore over the steel pontoon bridges (fig. 5-14), setting the pattern for every ensuing invasion in the war.

The pontoon was put to many uses. Various assemblies were made, including net tenders, causeways, floating cranes, drydocks, finger piers, seaplane service piers and ramps, and even an experimental aircraft landing field.

Post-World War II years have seen rapid technological and management system expansion throughout the engineering world and the Department of Defense. NAVFACENGCOM has been a leader in developing advanced management systems and adapting these to the latest computer hardware; examples are the Shore Facilities Planning and Programming System and the Seabee management tool, Seabee Tactically Installed Navy Generated Engineer Resources System (STINGER).

In the areas of engineering development, NAVFACENGCOM strives to turn the most up-to-date technological advances into the basis for efficient, economical shore facilities for the Navy. NAVFACENGCOM research is deeply involved in the future, with such concepts as underwater construction being studied in detail.

A major engineering accomplishment of the CEC was its direction of the massive Vietnam

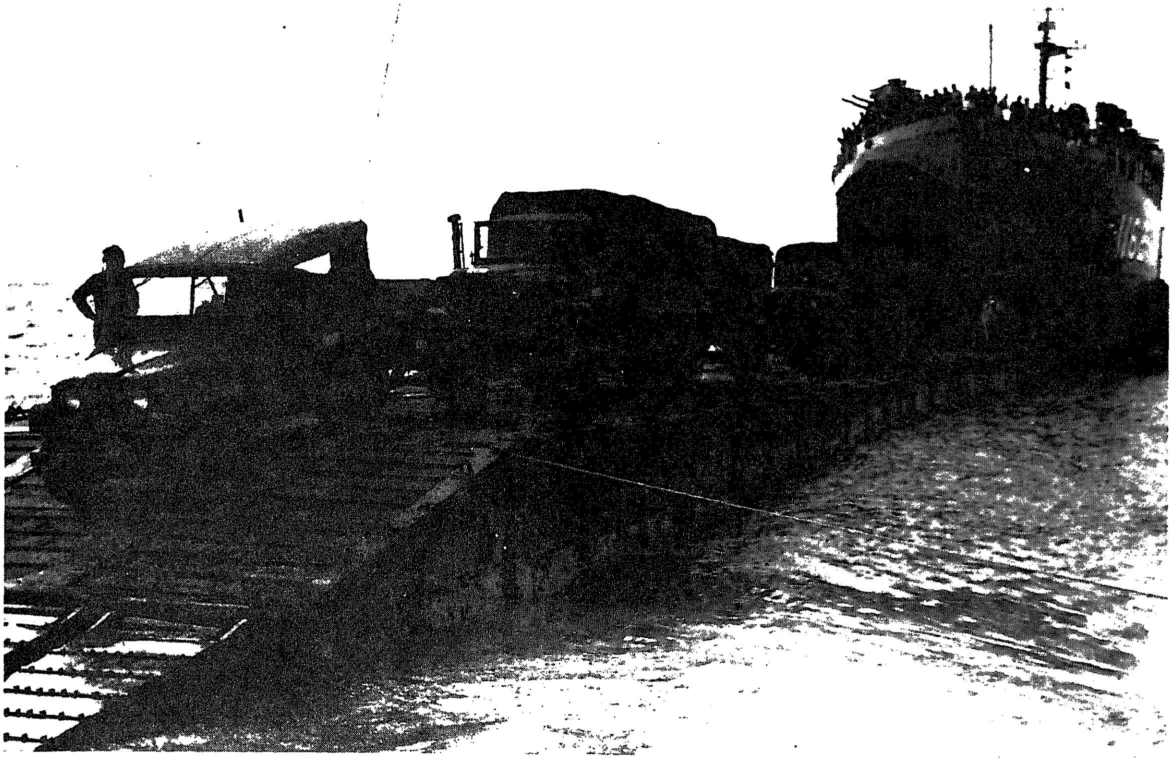

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Figure 5-14.—LSTs can launch pontoon causeways while underway or upon beaching, momentum carrying the causeways to the beach. When the marriage between LST and causeway is made, vehicles leave the ship under their own power.

construction program. Over 100 CEC officers directed the efforts of a 25,000-man civilian work force under the control of United States contractors in accomplishing a $2 billion program that considerably upgraded the entire face of the nation.

Many new engineering concepts have developed from the Vietnam experiences, including a new lightweight, high-strength replacement for the old pontoons discussed previously.

Throughout the years 1942-1968, however, the proudest CEC accomplishment has been the meteoric growth and fame of the Seabees.

THE SEABEES

The forerunners of the NCF date back to World War I when a construction regiment was formed to supplement the public works department in the construction of recruit training facilities at Great Lakes. A small detachment of the regiment also went overseas to build communication facilities in France. After the war, the regiment was decommissioned.

With the advent of World War II, the services of contractors and their civilian employees engaged in building naval projects overseas could not be used for construction work in combat zones. Under military law their status as civilians prevented them from offering resistance to an enemy without becoming liable to summary execution as guerrillas in the event of capture. Further, civilian workers lacked the training necessary to defend themselves.

Admiral Ben Moreell, who was the Chief of Bureau of Yards and Docks at that time (now

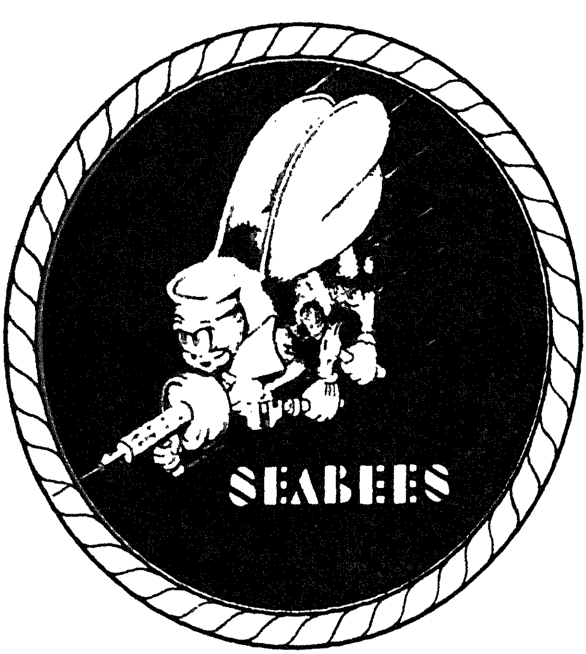

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Figure 5-15.—The CB insigne, appropriately enough, is a bee. Fighting mad, it is going into action carrying some of the tools of its trade—wrench, hammer, and spitting machine gun.

referred to as the King Bee), proposed the creation of a construction force within the Navy to meet the needs for uniformed men to perform construction work in combat areas. Three naval construction battalions (NCBs) were authorized in January 1942; they served under officers of the Civil Engineer Corps. The name "Seabees" is derived from the initials of the term *construction battalion*. See figure 5-15.

A battalion, still the fundamental unit of the Seabee organization, was composed of four construction companies, which included necessary skills for any job, plus a headquarters company consisting of yeomen, storekeepers, cooks, and so on. As a complete operating unit, a battalion could be sent into the field on its own. The complement was set at 32 officers and 1,073 men.

In the early stages of the war, the NCB operated overseas as an independent unit, with the officer in charge responsible for making all decisions of an engineering and military character. As the number of battalions in a given area increased, and as large construction projects were undertaken, a higher command echelon became necessary to coordinate the work. Consequently, naval construction regiments were established. In large areas where many battalions operated, brigades were formed. Finally, at Okinawa, a task force unit was created, embracing more than 100,000 Seabee and United States Army and British engineers. Altogether, 12 brigades, 54 regiments, and more than 150 battalions were formed. Peak strength was a quarter of a million men.

Construction of an advance base—the Seabees' primary function—was a complex task. A typical project was the construction of an airbase. The first job was to get equipment ashore despite enemy resistance. After the beachhead was established, roads had to be cut inland to the site of camp and airstrip. Supplies and equipment had to be moved off the exposed beach. Following this, many activities got underway simultaneously: A campsite was cleared and a source of water found and developed; hospital and messing facilities were set up; gun emplacements were built and radar protection installed; access roads were pushed through; and construction of the airstrip started. The menace of enemy aircraft was always present, with snipers sometimes operating from the jungle's edge. It took about 2 weeks to develop a fighter strip to the point where planes could land and take off.

Meanwhile, construction of other facilities had kept pace. A pier and dock had been built, and fuel tanks for aviation gas erected and camouflaged; power plants, warehouses, and shops had been put up and permanent structures for personnel replaced makeshift quarters; an administration building, dispensary, post office, and utility structures were made ready for use.

Such a base was built by a single battalion of Seabees, serving as part of an all-service airbase unit. For more extensive bases, such as an all-purpose base to fuel and repair ships, supply the fleet, and serve the fleet's air arm, three or more batallions were required.

The Seabees were assigned the construction of shipbuilding and ship repair plants; port and harbor works; aviation training and operating stations; ammunition depots and ordnance production facilities; supply depots, hospitals, fleet operating bases, and fuel depots; housing for officers, enlisted men, and civilians; and floating and graving docks of all sizes and characters. They constructed bases in the United Kingdom, Iceland, Newfoundland, Bermuda, the Caribbean area, Panama, South America, Africa, Alaska, and wherever the fighting forces went in the Pacific. Worldwide, Seabees constructed more than 400

advance bases—some accommodating 50,000 men—and housing facilities for 1.5 million men.

In 1946, the Seabees, originally established only as a wartime force, were made a permanent part of the Navy. In 1948, Group VIII (construction) ratings were established for enlisted Seabee personnel. Before that time, there were no construction ratings as such.

The main assignment of early postwar Seabees was to perform maintenance work at Navy overseas bases. Occasionally, they received assignments to perform special missions such as constructing housing at an advance base, or participating in special operations such as the atomic bomb tests and expeditions to the antarctic.

The most ambitious postwar project involved construction of Cubi Point Naval Air Station at Subic Bay in the Philippines. Seven years in the doing, construction of the field turned out to be an earth-moving chore comparable to digging the Panama Canal. The Seabees literally tore down a mountain to get the 17 million cubic yards of earth and rock needed to complete the job.

Cubi Point construction was accomplished in part for support of Korean operations. Amphibious construction battalions (described later, but mainly concerned with pontoonery and across-the-beach operations) played a key role in supporting the Inchon landing. Other Seabee units built airfields and maintained Marine facilities. Several battalions were deployed to the Philippines (such as those involved in the Cubi job), Okinawa, and other Pacific island bases to build support facilities vital to the Korean logistics chain.

From 1953 onward Seabee battalions (now called NAVAL MOBILE CONSTRUCTION BATTALIONS [NMCBs]—the term truly fits; every piece of today's specially designed Seabee equipment can be airlifted) worked in such places as Cuba, Spain, Newfoundland, Guam, Okinawa, and the Philippines.

In May of 1965, the then 10,000-man Seabee force was called on again, and MCBs went across the beach in Chu Lai, Republic of Vietnam. During the peak of the conflict, Seabee strength more than doubled to 25,000 men in 21 battalions. Nearly $100 million of construction had been placed during more than 3 million man-days of grueling effort by the Seabees. Jobs were diverse, ranging from construction of huge logistics complexes in Da Nang and Chu Lai in the early phases of the conflict to building camps in remote locations for the Army's Special Forces (Green Beret) troops.

The breakdown of NCF includes the following basic elements:

- Naval construction brigade (NCB)
- Naval construction regiment (NCR)
- Amphibious construction battalion (PHIBCB)
- Naval mobile construction battalion (NMCB)
- Construction battalion maintenance unit (CBMU)
- Construction battalion unit (CBU)
- Naval support unit (NSU)

A brigade consists of two or more regiments; a regiment is composed of two or more mobile construction battalions; and the battalion still consists of five companies, although manning is now at 550 to 750 as opposed to the World War II 1,000-man battalion. The basic operational component is the battalion, as it has been since the construction forces were created in 1942. The brigade commander directs and coordinates activities of Seabee regiments. Regimental commanders coordinate the efforts of attached battalions, provide home base facilities, issue needed material and equipment, and provide administrative support training.

The function of an ACB (or PHIBCB) is to provide engineering support required by a naval beach group during an amphibious operation. The task of a beach group is to support a division of troops, as a minimum, during the assault phase of the operation. The role of a PHIBCB is to provide pontoon causeways, beach salvage teams, beach improvement teams, and ship-shore fuel systems—each function being performed by a platoon specially trained for the job. A PHIBCB is self-sufficient, but normally it is not intended for lengthy deployment in the field. When the beach group's operation is completed, the PHIBCB's mission also has been accomplished.

An NMCB is an independent, self-sustaining unit organizationally designed to operate alone. It can accomplish a large variety of construction missions—roads, bridges, airstrips, fuel storage tanks, water supply system, and electric installations, to name just a few—in addition to erecting probably any type of building. The composition of an NMCB necessarily represents a large cross section of the building trades—carpenters, plumbers, electricians, engineers, surveyors, heavy equipment operators, and so on.

The primary job of the Seabees is to build, but, based on the theory that they can't build unless they control the jobsite, all Seabees receive training in defensive combat tactics. Controlling the jobsite involves the second part of being a Seabee, the fighting part, as exemplified by the Seabee motto *Construmus Batuimus* meaning We Build—We Fight.

Each company in a battalion organization is divided into combat platoons, squads, and teams (fire, machine gun, and rocket). A Marine gunnery sergeant is assigned on an augmented basis as a military advisor and training specialist to the commanding officer of the battalion.

As a self-sustaining unit, the NMCB in particular must be capable of self-defense for a limited time. Each battalion subdivision has a construction/military support assignment, and every officer and man fills a construction/military support billet. The construction aspect, of course, predominates; the mission is to build. Platoons are organized into work crews that correspond to the weapon squad organization. The basic construction/military support units, then, are the work crew/rifle fire team, work crew/ automatic weapons team, and the work crew/ rocket launcher team.

The function of a CBMU is upkeep and maintenance of completed bases. It is also equipped, however, to accomplish relatively light construction projects.

Seabees have constructed numerous antarctic bases since 1955. CBU did the base construction during the summer season while a maintenance unit wintered over for the purpose of upkeep. Presently CBU's are constructing and working on bases around the world.

The Naval Support Unit (NSU), State Department, provides construction support to the U.S. Department of State. The duty involves the inspection of foreign contract construction and the accomplishment of minor construction and repairs within secure areas of foreign service buildings overseas. The activity has a personnel strength of volunteers and is commanded by a CEC lieutenant commander or lieutenant. The enlisted personnel are second class petty officers or higher. Married personnel are assigned to unaccompanied tours initially and then to a 2-year accompanied tour. Unmarried personnel customarily remain in a transit status during most of their tour. The Navy is reimbursed by the Department of State for all costs associated with this unit.

Seabee teams consist of 1 CEC officer and 12 enlisted men. Every man is cross-trained in at least one rate other than his own, so that, in essence, the capability of each highly diversified team actually is more than double that of the indicated manpower. The teams comprise a breed of civic action/counterinsurgency builder-fighters that can be flown, with their equipment, anywhere in the world on short notice. They are self-sufficient in the field and can do a variety of construction tasks. In general, teams serve as goodwill ambassadors, building or advising on the construction of public works projects in small nations unable to accomplish the tasks themselves. They have been assigned to a number of countries and trust territories in the Pacific to build roads, drill water wells, and erect schools.

In Vietnam, teams went out among the people for months at a time as part of the people-to-people civic action program to advise on sanitation and health matters, take care of the sick (a specially trained hospital corpsman was assigned to each team), and to teach basic construction skills to villagers. A Seabee team member, Marvin Shields, CM3, was the first Navy man to win the Medal of Honor in Vietnam.

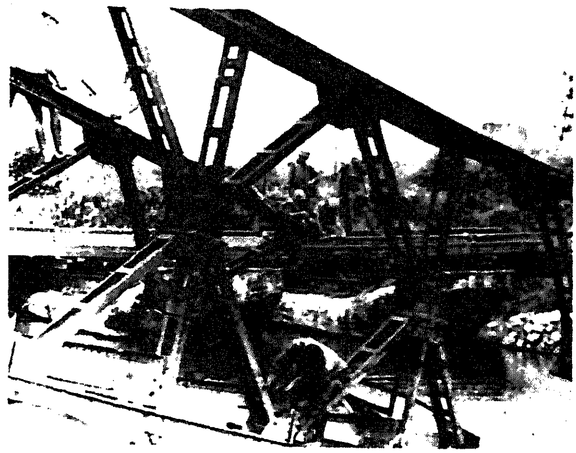
Figure 5-16 illustrates the diversity of Seabee functions in Vietnam.

THE SUPPLY CORPS

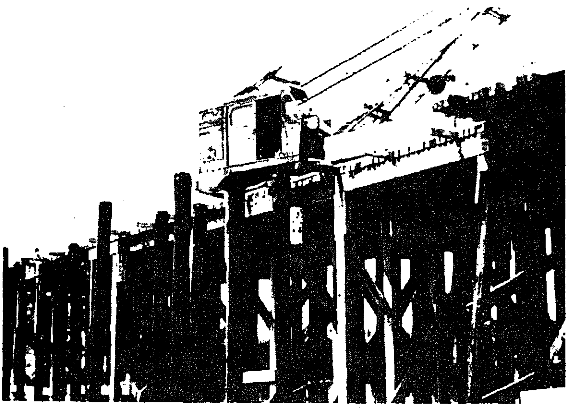
Officers of the Supply Corps are the Navy's business administrators. As such, they are responsible for ensuring that the vast logistics requirements of the Navy, as set forth by the Chief of Naval Operations, are provided efficiently and economically to ships and activities around the world. This entails the management of a supply system that must furnish well over a million items essential to the operations of ships, missiles, aircraft, and facilities. In addition, Supply Corps officers manage the operation of food service, ship's store, and navy exchange facilities; and disburse pay and allowances of Navy men and women.

Duty assignments of Supply Corps officers range from that of supply officer aboard a destroyer to the Commander, Naval Supply Systems Command, a rear admiral, who also serves as the Chief of the Supply Corps. The Naval Supply Systems Command is responsible for overall management of supply ashore and afloat. Disbursing and certain other comptrollership billets to which Corps officers may

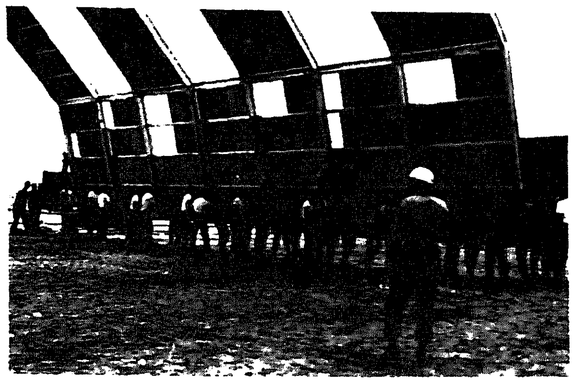
A. STEELWORKERS REMOVE ROCKET-DAMAGED STEEL MATTING FROM AN AIRFIELD PARKING APRON.



B. BRIDGE EXPERTS SURVEY VIET CONG-BLOWN BRIDGE.

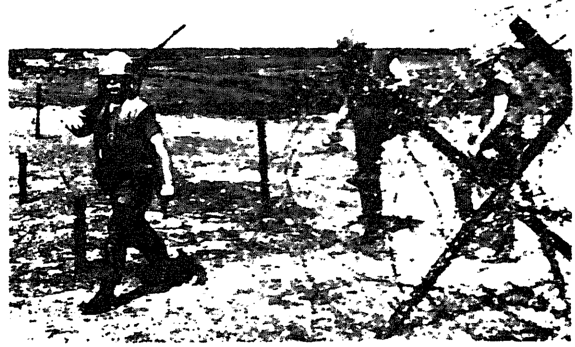


C. UNITS OF AN NMCB CONSTRUCTING A BRIDGE.



D. ERECTING A HANGAR FOR THE MARINES.

E. WORKING ON A CANTONMENT FOR ROK TROOPS.



F. PERIMETER PATROL RETURNING TO BASE.

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Figure 5-16.—All construction battalions were committed to Vietnam. More than 50% of those in the country were, or had been, engaged in providing tactical support construction to United States and Allied forces under fire.

be assigned are under the management of Comptroller of the Navy.

The afloat supply officer is chiefly concerned with procurement, receipt, custody, stowage, and expenditure of material for ship's use; maintenance of stock records and inventory control; food service and ship's store operations; and payment of the crew. Ashore, billets involve requisitioning and local procurement, contract purchasing, material inspection and receipt, stock management at field supply points, supply systems management, storage and materials handling, and financial management.

Current corps strength is about 4,500 officers, 50 percent of whom serve afloat and overseas. The main source of Supply Corps officer input is the NROTC (regular) Program including some hard science majors. Others are received from the Naval Academy, OCS programs, the LDO Program, and line officer transfers. While not officially members of the corps, about 300 warrant and chief warrant officers serving in the technical specialty of Supply Clerk also are assigned to Supply Corps billets, both afloat and ashore.

Newly commissioned Supply Corps officers, including line transferees, and newly appointed Warrant Supply Clerks are sent to the Navy Supply Corps School, Athens, Georgia, for 26 weeks of intensive training in Basic Supply Management. In addition, they receive instructions in a wide range of sophisticated management techniques, including automatic data processing. On completion of the course, most corps officers are initially assigned to afloat billets followed by tours ashore in CONUS and overseas. The typical rotation pattern of corps officers is discussed in chapter 3. By his or her third tour, the typical Supply Corps officer is expected to develop a functional proficiency in one of the following fields: clothing and textiles, financial management, fuel distribution, merchandising, procurement, subsistence technology, system inventory management, or transportation management.

Courses in Navy Exchange Management (6 weeks) and Commissary Store Management (4 weeks) are conducted several times yearly at the Navy Ship's Store Office, Brooklyn, New York. A 6-month course in Transportation Management, conducted at the Naval Supply Center, Oakland, California, covers material on terminal operations and stevedoring, traffic management, and warehousing. Supply Corps officers also are eligible to attend other courses of varying length conducted at both military and civilian facilities on subjects ranging from petroleum storage to computer systems.

Development of a functional proficiency in no way detracts from the Supply Corps officer's overall opportunity to upgrade his or her professional qualifications as a naval officer. Each year approximately 100 Supply Corps officers are selected for postgraduate training at military and civilian institutions, some at the doctorate level. Studies range from logistics and management sciences to law and personnel administration. Long-range plans for the Supply Corps officer envision him as a technoeconomist skilled in mathematical sciences, analytical methods, and behavioral sciencies essential to future Navy operations.

THE NAVAL MEDICAL COMMAND

The term *Naval Medical Command* designates the worldwide medical and dental services and facilities maintained by the Department of the Navy in accomplishing its assigned mission within the national defense structure of the United States. The mission of the Naval Medical Command is to safeguard the health of Navy and Marine Corps personnel. This includes care and treatment of sick and injured members of the naval service and their dependents; training programs for Naval Medical Command personnel; continuing programs of medical and dental research; prevention and control of diseases and injuries; promotion of physical fitness in members of the naval service; care for on-the-job injuries and illness of civilian employees; and supervision of the care and preparation of shipment and interment of deceased military members and of civilian personnel for whom the Navy is responsible.

Members of the medical profession have always played an important role in the Navy. They have served with gallantry and distinction on every type of fighting ship, from the *Alfred*, the vessel on which John Paul Jones hoisted the first American flag in 1775, to the modern nuclear-powered submarines.

The history of Navy medicine shows that it is increasing in professional competence, specialization, mobility, and prestige—results due, in no small part, to the organized efforts of its members. In the early days of the Navy, however, physicians were selected by commanders of naval vessels for individual voyages. Medical officers were not formally organized and had little, if any, relation to one another. Interesting travel and

a share in any booty a ship might capture served as inducements to join the Navy.

In the early days of the Navy, medical and surgical attention was provided by Surgeons or Surgeons' Mates. Their assistants, selected from the crew, were known as "loblolly boys," a designation used in the British Navy; the term was derived from the name of a porridge served to the sick and injured. Loblolly boys were ill trained, but undoubtedly many of them gave of themselves a full measure of their capabilities; they were the nucleus of a group much later organized into what is now the Hospital Corps.

While naval regulations, as early as 1798, called for a convenient place to be set apart for sick and hurt men aboard naval vessels, the ill-ventilated, poorly lit, and inadequately equipped spaces reserved for the care of the sick on early ships was a far cry from the completely appointed sick bays of today.

The lifesaving drugs and effective techniques of modern medicine were unknown. Surgeons lacked adequate anesthetics and antiseptics. Great faith was placed in vinegar as a germ killer; rum and opium compounds were the most frequently used agents for deadening pain.

ORGANIZATION OF THE NAVAL MEDICAL COMMAND

The first real effort to provide a distinct medical organization within the Navy Department was made in August 1842, when Congress established the Bureau of Medicine and Surgery. Surgeon William P. C. Barton, who 27 years before had published the *Scheme for Systematizing the Medical Department of the Navy*, was chosen as the first chief of the bureau. He was offered, but refused, the additional title of surgeon general. He was selected from a list of 60 surgeons then serving in the Navy.

In the 1860's, the Bureau of Medicine and Surgery (BUMED) expanded with the growth of the Navy. During this decade, the hospital at Washington, D.C., was built; the Annual Reports of the Surgeon General, later to be of much value to public health authorities and other officials, were continued; and the Navy's first designated hospital ship, *Red Rover* (fig. 5-17), was commissioned. This ship, a sidewheeler captured from the

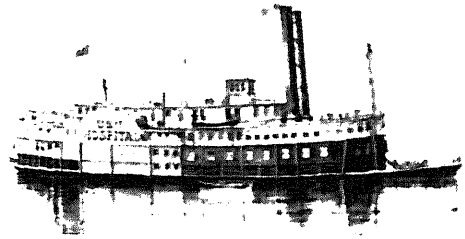

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Figure 5-17.—USS Red Rover, the Navy's first regular hospital ship, was in use during the Civil War. The Navy's first female nurses served aboard her.

Confederates, was converted into a hospital ship at St. Louis. Virtually a floating palace for its time, it had elevators between decks, fully equipped wards, screened windows, well-appointed operating rooms, and nine water closets. The Navy's first female nurses also served aboard *Red Rover*.

In 1871 medical officers were no longer listed simply as surgeons, but as members of a staff corps of the Navy. They were given grades of medical director, medical inspector, surgeon, and past assistant surgeon, the grades being generally comparable to captain, commander, lieutenant commander, and lieutenant, respectively. Assistant surgeons on their first cruise had the relative rank of ensign.

Rating designations of enlisted personnel have gone through many changes. The loblolly boy was succeeded, in 1843, by surgeons' steward. During the Civil War, male nurses were enlisted and assigned to receiving ships in a number proportionate to the necessities of the case. The designation of surgeons' steward was changed to that of apothecary in 1866; about 1873, the male nurse became a "bayman." These designations remained until 1898, when the present Hospital Corps was established.

In 1883 the Museum of Naval Hygiene was founded in Washington. The first *Instruction for Medical Officers*, a compilation of naval regulations affecting BUMED, was revised. It had first been published in 1867 when Gideon Welles was Secretary of the Navy. After the 1909 edition, this book was titled *Manual of the Medical Department, United States Navy*, with a drastically improved edition in 1914.

The grade of rear admiral was given to the rgeon General of the Navy in 1899, and JMED thus acquired added prestige.

Under Surgeon General Rixey and President eodore Roosevelt, annual physical examina- ons for officers were inaugurated.

The Nurse Corps (female), forerunner of the esent-day Navy Nurse Corps, was created by act of Congress in 1908.

In 1911 antityphoid vaccination was made andatory, and the systematic teaching of first l was instituted. In the following year, the ental Corps was established under the new rgeon General, Charles F. Stokes.

The rating of hospital steward was officially anged to pharmacist's mate (PHM) in 1916; the ospital Corps was established by Congress at /2 percent of the enlisted strength of the Navy d the Marine Corps.

In 1947 the Medical Service Corps was ablished to provide commissioned grades for rsonnel in administration and supply, phar- acy, optometry, and medical allied sciences; the urse Corps, a component of BUMED, was ablished as a staff corps of the Navy in April 47; and the rating of pharmacist's mate was anged to hospital corpsman.

During World War I, the Medical Corps made table improvements in sanitation and the ntrol of infectious and contagious diseases, such typhoid and scrub typhus.

Bureau of Medicine and Surgery personnel ndered outstanding service to the men of the urth Marine Brigade, part of our Second vision, in France. At Belleau Wood, Chateau- ierry, and St. Mihiel, among other battles, spital corpsmen and officers shared the dangers d brought succor to the wounded. A total of Medical Corps officers, 12 Dental Corps ficers, and 500 hospital corpsmen of the Navy re assigned to field service with the Marines. 17 Medals of Honor awarded to the armed ces during the war, 3 were won by officers of Navy Medical Department.

In preparation for overseas assignments, rpsmen and doctors trained with the ground ops from the first days at Quantico, Virginia. Out of these weeks of training, an organization of medical facilities was developed—the first practical school of field medicine in the United States, which foreshadowed the later development of medical support for Marine Corps amphibious landings in World War II.

During World War II, the largest waterborne medical department in the history of warfare was created. By August 1945, there were 42 established naval hospitals, as well as 12 special hospitals, with a patient load of 81,445, and also many smaller medical units for medical treatment, physical examinations, immunizations, and short-term care. In this, the most destructive of all wars, BUMED achieved a remarkable record in saving human lives. Despite the fact that bombs and high explosives produced wounds of a far more serious nature than in any previous warfare, about 97 of every 100 wounded men managed to survive. This mortality rate of less than 3 percent, compared with 11.1 percent in World War I, was due to several factors.

Casualty evacuation from beachheads to advanced base hospitals and joint operation with line personnel of ships and aircraft was a highly important contributing factor to this high rate of survival. In many cases, transport by water or air was so rapid that casualties were being operated on at a rear base hospital 2 hours or less after being wounded. Hospital ships incorporated the most advanced improvements of permanent hospitals ashore and were completely air-conditioned. Air evacuation, pioneered on a large scale by Navy medical officers and hospital corpsmen attached to the Marine Corps in the early campaigns in the South Pacific, likewise ranks high among factors resulting in such low mortality.

Hospital corpsmen, who braved death to aid the wounded where they fell, deserve the highest credit for their contribution to the achievement of BUMEDs mission. In some cases, their casualty rate was higher than that of the troops they were supporting. The Hospital Corps won its deserved reward in the form of a presidential citation, which was the first time in naval history that an entire combat organization was cited for heroism.

In previous conflicts in which this nation engaged, deaths of naval personnel from disease far outweighed those of enemy action. World War II reversed the ratio. The early and successful use

of vaccines, antitoxins, and other preventive measures accounts for the unusually low disease rate among servicemen.

The effectiveness of preventive medicine is dramatically shown by the low mortality rate from diseases among American combat troops on Guadalcanal, where jungles were sources of malaria and jungle fevers. Thousands of Japanese on that island perished from disease. But Americans listed as dead (from all causes) or missing on Guadalcanal totaled only 1,500.

In addition to its highly important task of caring for the wounded, the Medical Department during World War II handled an enormous case load of ordinary sickness and injuries. Some 90,000 wounded were treated, but over 50 times that number of cases of disease and noncombat injury were handled. Many new and improved methods of treatment were developed.

During the war, BUMED expanded its personnel to a strength of 170,000—a total larger than the regular force of the Navy before the war. Of this number, about 21,000 were medical and dental officers and 11,000 were nurses.

Since World War II, Navy physicians and dentists have further advanced their professional techniques and have made more mobile the medical care they provide combat forces.

In the Republic of Vietnam, wounded men were quickly evacuated by helicopter directly to the decks of hospital ships. Patients requiring long-term specialized care were evacuated by air to appropriate facilities in the United States. Physicians participated in the planning of operations to avoid strategic assaults in disease-ridden areas or to assure that control measures would be ready if such assaults were made. A mobile dental laboratory with its own power plant provided most types of dental care close to the front lines. Surgical teams with their equipment moved about by air to supplement regular medical support wherever they were needed, particularly in combined Navy and Marine Corps amphibious assault operations. Devices such as fully equipped surgical trailers brought definitive care to frontline troops.

Figure 5-18.—A hospital corpsman bandages the leg of a wounded Marine during a search-and-destroy sweep near An Hoa, South Vietnam. The helicopter in the background brings in more troops and will evacuate the wounded. **134.139**

In Vietnam, hospital corpsmen served with elements of the Fleet Marine Force while under fire. In figure 5-18, a hospital corpsman bandages the leg of a wounded Marine prior to the Marine's evacuation by helicopter. The benefit of quick evacuation to the morale of the fighting man is an important answer to the why of aeromedical airlift. Only 1 percent of personnel injured by hostile action in Vietnam died after reaching a medical facility. In Korea, where fewer than 15 percent of the wounded were moved by helicopter, the rate was 2 percent; and in World War II, with no helos, the rate was 4.5 percent.

Medical personnel were active in the Vietnam

134.140

Figure 5-19.—Participating in the civic action program, members of the MedCAP team journeyed to the island of Ky Xuan twice each week to minister to the medical needs of the people.

the medical needs of the people. The hospital corpsman shown in figure 5-19 is treating an injured 85-year-old woman while she talks to the chaplain and other members of the MedCAP team.

NAVY MEDICINE TODAY

The first naval hospital was opened in Portsmouth, Virginia, in 1830. In its earliest days, the medical staff was limited to five men and very little equipment. The steady progress made in the naval hospitalization system since 1830 has kept pace with the rapid strides made in civilian hospital services and medical education in the United States during the past century. As of 1976, the Navy had 14 hospitals, 21 medical centers, and 198 clinics.

A naval hospital provides relatively full diagnostic and therapeutic service together with bed care, nursing, and dietetic services. Because accessibility and capacity to serve the operating forces are prime site considerations, most hospitals are located along the coastal states. Station hospitals can offer extended care to patients, but they are smaller and more limited in scope. A clinic is designed mainly to provide examination and treatment for ambulatory patients and first aid for emergency cases.

The largest dental facilities ashore are naval dental clinics, established in areas of heavy personnel concentration. Equipped and manned to furnish complete dental care, there are about 10 clinics worldwide. Services rendered by dental departments at other shore installations

depend on the size of the dental facility, which, in turn, relates to the number of personnel served.

Aboard ship, the scope of medical facilities is contingent upon the complement of medical personnel, available space and equipment, capability of the staff, and mission of the ship. Facilities thus range from the scantily furnished sick bay of a destroyer to one that is fully equipped aboard a carrier. Personnel assigned vary from 2 hospital corpsmen on destroyer types (the senior being specially trained for independent duty) to perhaps 40 or 45 officers and men on aircraft carriers. The type or class of a ship normally determines the size and capacity of its dental facility.

THE CHAPLAIN CORPS

Among the various needs of naval personnel is that of religious ministry. Just as he is responsible for the military performance of the personnel of his command, the commanding officer also has a definite responsibility for ensuring that the religious needs of the men and women under his command are met. Chaplains are assigned to commands, therefore, to assist in the fulfillment of that responsibility and to support the preservation and enhancement of the moral and spiritual well-being of the personnel of the command.

The Navy Chaplaincy, established November 28, 1775, has played a significant role in providing support and spiritual guidance for naval personnel and their dependents. Though commissioned as an officer, the chaplain is first an ordained member of the clergy in one of the religious bodies of the country. The wearing of the naval uniform enhances the chaplain's effectiveness as he attempts to provide ministry within and to the military organization. The uniform, itself, indicates responsibility to the naval service and the nation. The insignia worn, the Cross or the Tablets of the Law, identify the chaplain and emphasize responsibility to church and spiritual values.

Standards for appointment as a chaplain are high. Each appointee must be physically qualified. Each must have completed at least 120 semester hours of undergraduate study in an accredite college or university and a minimum of 9 semester hours in an approved theological schoo Before the appointment can be made, the chaplai must be duly ordained by his own church an provided with an ecclesiastical endorsement b that church.

As a religious leader, the chaplain is a advisor to the commanding officer on all matte pertaining to the moral, spiritual, and religiou welfare of Navy and Marine personnel. Divin services conducted by the chaplain are alway in accordance with the customs, tradition and regulations of the chaplain's own churc Frequently called upon to provide religiou services for those of other faiths, however, th chaplain's responsibility includes such functio as inviting appropriate clergy aboard, training la leaders, and providing proper material an ecclesiastical support to facilitate appropriat services for men and women of all faiths. Eac chaplain is called upon to use ideas, technique and methods that will assist the development o personal growth and good character in all perso in the command.

Additionally, home and domestic problem troubling personal issues and crises, as well general welfare concerns shape the pastoral ca dimension of the chaplain's responsibility. Oft the bulk of the chaplain's effort is devoted pastoral care and pastoral counseling. Eve chaplain soon learns of persons who are perplex or distraught and who are in need of counsel a assistance. And, too, chaplains regularly recei requests for instruction for baptism, confirm tion, and for marriage.

Chaplains serve at sea on a normal rotation basis. Some are assigned directly to ship companies. Others have become "circuit riders to meet the needs of those on small ships an stations or when units are widely dispersed. Fo example, a chaplain assigned to minister destroyer personnel will, in fact, serve many shi operating over great distances. Over 50 perce of the Navy chaplains are in sea or overseas bille In addition, Navy chaplains accompany maj tactical and support units of the U.S. Mari Corps. Approximately 20 percent of the tot number on active duty are attached to Mari Corps units at any given time. Ashore, thr or more chaplains may be assigned to larg Navy, Marine Corps, and Coast Guard station

134.50

Figure 5-20.—On the naval base at Norfolk, Virginia, are the chapels of three faiths under one roof. To the left is the Protestant chapel; to the right, the Catholic chapel, and connecting the two, the Jewish chapel.

many of which have well-equipped chapels and educational facilities (fig. 5-20).

Chaplains serve in commissioned grades from lieutenant (junior grades) through captain and are promoted in accordance with the same precepts and regulations that govern all other naval officer promotions. The Corps, itself, is directed by the Chief of Chaplains, a rear admiral. A second rear admiral serves as detailed by the Chief of Naval Personnel.

JUDGE ADVOCATE GENERAL'S CORPS

Although the American Fleet was authorized in 1775, and the Department of the Navy was established by an Act of Congress in 1798, the Navy had no official legal counsel until well into the 19th century.

FORMATION OF THE OFFICE OF JUDGE ADVOCATE GENERAL

In 1864, because of contract frauds arising under Civil War naval programs, Secretary of the Navy, Gideon Welles, created the position of Solicitor for the Navy Department. The quickly proven value of the Solicitor's function moved Secretary Welles to request legislative ratification of the new legal office, and, by the Act of 2 March 1865, Congress established the Office of Solicitor and Naval Judge Advocate.

The Act of 8 June 1880 established the Office of the Judge Advocate General of the Navy as we know it today. This legislation placed upon the Judge Advocate General the duty to "receive, revise, and have recorded the proceedings of all courts-martial, courts of inquiry, and boards for the examination of officers for retirement and promotion in the naval service, and to perform such other duties as have heretofore been performed by the Solicitor and Naval Judge Advocate General." The Judge Advocate General was given cognizance over all legal matters, of whatever kind, that affected the interest of the Navy.

Tremendous legal problems, some of highly intricate character, were generated by World War II. In particular, great difficulty arose in

connection with the preparation and administration of the Navy's contracts for the procurement of goods and services. To solve the immediate crisis, a unit of civilian attorneys were gathered, which, in 1944, evolved into the Office of the General Counsel of the Navy.

Establishment of the Office of General Counsel brought about a dichotomy in the Navy's legal heirarchy that exists today. The Judge Advocate General is given, in addition to military justice and military law functions, cognizance of all legal duties and services throughout the Department of the Navy other than those specially assigned to the General Counsel for the Department of the Navy. Functions assigned to the Office of the General Counsel are in the fields cf business and commercial law.

FORMATION OF THE JUDGE ADVOCATE GENERAL'S CORPS

Before World War II, Navy lawyers were generally line officers with legal training, and their tours of legal duty, usually in the Office of the Judge Advocate General, alternated with tours of line duty at sea. During the war, large numbers of lawyers served in an admixture of line and legal functions throughout the world.

The idea of organizing the Navy's uniformed lawyers into a distinctive professional group performing only legal functions was first considered a number of years ago. In 1945, the Secretary of the Navy convened the McGuire Committee (chaired by Matthew F. McGuire, a prominent civilian lawyer) to examine court-martial procedures under the Articles for the Government of the Navy. In its November 1945 report to the Secretary, the committee formally recommended, among other things, establishment of a Judge Advocate General's Corps in which officers would perform legal duties only, with promotions in the Corps to be predicated mainly upon professional competence in the performance of such duties. The committee reasoned that combining legal functions with line functions was no longer feasible in that legal difficulties incident to modern warfare require full-time, first-rate lawyers just as operational aspects of naval warfare require full-time, first-rate line officers. It was considered unrealistic to expect efficiency in these increasingly divergent and technical areas from the same individuals.

The recommendation of the McGuire Committee for creation of a Judge Advocate General's Corps prompted Secretary of the Navy Forrestal to appoint a board headed by Arthur A. Ballantine of the New York Bar to look further into the question. In April 1946, the Ballantine report concluded that World War II had demonstrated beyond all question the need to employ a large number of lawyers for the performance of legal duties on a continuous basis, but recommended the creation of "law specialist" as a category in the restricted line as being more advantageous to the Navy than creation of a JAG corps. In June 1946, the procurement of 300 lawyers was authorized, and the law specialist program was implemented.

It was assumed originally that law specialists would supplement, not replace, line officers trained in law. The authorization for 300 law specialists was predicated on this assumption and upon the requirements of a Navy operating under the Articles for the Government of the Navy. In May 1950, however, enactment of the Uniform Code of Military Justice to supplant the Articles established new requirements for legal services. Many functions in the court-martial system created by the code had to be performed by law specialists, and could not be performed by other officers, even though trained in law. As a result, in the years after enactment of the code, the number of required law specialists almost doubled. It became apparent that law specialists should supplant, rather than merely supplement, unrestricted line officers in the performance of legal duties.

During ensuing years, numerous recommendations for establishment of a JAG corps were made. The attempts were unsuccessful until late in 1967, when a subcommittee of the House Armed Services Committee scheduled a hearing on provisions for the establishment of a JAG corps in the Navy. The Judge Advocate General of the Navy, appearing at the hearing, presented convincing testimony to show that membership in a legal corps would give the Navy lawyer a sense of professional identity and provide a potent career incentive.

The proposed legislation made the full course through a receptive Congress from subcommittee hearings to final passage within a period of little more than 2 months. Public Law 90-179, the bill establishing the JAG Corps as a staff corps of the Navy, was signed into law by the President on 8 December 1967.

All law specialists, including women, of the regular Navy and Naval Reserve were redesignated as judge advocates (JA) in the JAG Corps. The statute also provides that, upon request, the Judge

Advocate General may designate qualified Marine Corps lawyers as judge advocates, thereby entitling them to perform the same functions as Navy judge advocates, although Marine Corps officers do not become members of the Navy JAG Corps by virtue of such designation.

The JAG Corps is identified by a device comprised of two gold oak leaves curved to form a semicircle, the center of which is a balanced silver "mill rinde." A mill rinde is the metal bar inserted between the two stones of a mill to bear and guide the upper stone equally in its course—to prevent it from inclining too much on either side—thus ensuring that all the grist is ground evenly. For some 6 centuries, the mill rinde has been constructed in the English-speaking world to symbolize equality and justice, and it has been associated with the legal profession.

The JAG Corps legislation entitles the Judge Advocate General and Deputy Advocate General to the grades of rear admiral (upper half) or major general, U.S. Marine Corps. The statute also created two positions for Assistant Judge Advocates General and authorized the two officers detailed to those positions to hold the grades of rear admiral (lower half) or brigadier general, U.S. Marine Corps.

FUNCTIONS OF THE JAG CORPS

Military justice is only one of the many areas of responsibility that are handled by Navy lawyers. JAs also are responsible for legal advice in the fields of international law, admiralty, claims, litigation, promotions and retirements, investigations, administrative law, taxation, and legal assistance to service members and their dependents.

Activity in these fields and in military justice is constantly expanding and changing. The largest change, in terms of expanded rights to military people, occurred with passage of the Military Justice Act of 1968. This act expanded the rights of the accused to include lawyer counsel before special courts-martial and inaugurated the use of military judges to preside over special courts-martial.

JAG Corps members serve in the offices of the Secretary of Defense, Secretary of the Navy, Chief of Naval Operations, Chief of Naval Material, Chief of Naval Personnel, Chief of the Bureau of Medicine and Surgery, Chief of Naval Research, Comptroller of the Navy, and the Joint Chiefs of Staff, among others.

Additionally, JAs are assigned to the staffs of the commandants of the various naval districts to handle legal work generated within the district. Locally, they serve on the staffs of fleet, force and type commanders, and at many naval bases, stations, and schools.

Since 1969, the JAG Corps has been organized into four basic components—the Office of the Judge Advocate General, staff and activity judge advocates, law centers, and a training component. Under that organizational structure, the corps experienced problems in personnel distribution, uniformity of funding and support, and standardization of operations. These problems impeded the corps' efforts to render optimum service.

Following an extensive study of the problem, the Naval Legal Service was established in 1973 with the following mission: To administer the legal services program and provide command direction for all Naval Legal Service activities and resources as may be assigned; and to perform such other functions or tasks as may be related to the Naval Legal Service as directed by the Chief of Naval Operations.

Basically, the mission of the Legal Service Offices is substantially the same as the former law centers. Headquartered in Washington, the Naval Legal Service was authorized 18 offices and 15 branch offices throughout the world. Technically, the offices serve as legal-service centers in areas of major concentrations of naval activities. Within the limits of strength authorizations, they provide a full array of legal services to commands that have no judge advocate assigned. A primary purpose of the reorganization, and the Naval Legal Service, was to bring all trail and defense counsels under the direct authority of the Judge Advocate General, thus making them independent of court-martial convening authorities.

Even though they are relatively new on the scene as an organization, the responsibilities of the Navy JAG Corps continues to expand concomitantly with the passage of legislation by Congress and the increased need for legal services by Navy members.

WOMEN IN THE NAVY

Women are an integral part of the Navy; they are recruited, trained, and assigned under the same regulations as the men and are entitled to the same benefits. They serve in a wide variety of assignments within the United States and in overseas areas. The law does not permit them to serve aboard Navy combatant ships, nor may they serve on aircraft engaged on combat missions.

Although nurses had served with the U.S. Navy for many years, it was not until World War I

that women, other than nurses, became a part of the Navy. These yeomen(F) were enlisted in the Naval Reserve; about 11,000 served in the United States as well as in Hawaii, France, Guam, and Panama primarily in stenographic billets. They also served in billets as translators, draftsmen, fingerprint experts, camouflage designers, and recruiters. At the end of the war, all women were released from active duty.

Early in World War II, the Navy again faced acute personnel shortages. Recognizing the fact that women could be used to expedite the war effort, Congress, on 30 July 1942, passed legislation authorizing the procurement of 1,000 officers and 10,000 enlisted women for the Naval Reserve. WAVES (women accepted for volunteer emergency service) were from the beginning an integral part of the naval service. They have never been a separate corps or an auxiliary. Later, the original legislation was so modified that by the end of World War II, more than 86,000 women were on duty in the continental United States and Hawaii. This spectacular growth was due to the fact that WAVES proved able to take over many more jobs than was at first believed possible. WAVES, officer and enlisted, were on duty in nearly every type of shore activity, including naval air stations, naval hospitals, naval district headquarters, and supply depots. Enlisted WAVES served as yeomen, disbursing clerks, and Link trainer instructors. They packed parachutes, collected weather information, and directed air traffic from control towers.

WAVES composed 55 percent of the uniformed personnel in the Navy Department in Washington. In "Radio Washington," the nerve center of the entire Navy communications system, women composed 75 percent of the total allowance. Seventy percent of all naval personnel on duty in the Bureau of Naval Personnel were WAVES. About 13,000 WAVES were in the Hospital Corps, serving in naval hospitals and dispensaries.

Women officers served as line officers in assignments that used their knowledge and education as administrators, language specialists, communicators, and educational service officers.

The outstanding record established by women in the military service during World War II paved the way for passage of the Women's Armed Services Integration Act in 1948; under this law Navy women became a permanent part of the regular Navy and Naval Reserve. The basic philosophy underlying the Navy's endorsement and subsequent implementation of the 1948 Act was two-fold—to make available to the Navy the skills of women in noncombat assignments and to maintain within the permanent naval establishment a nucleus of officers and enlisted women upon which to build in the event of a national emergency. The women in the Navy would provide the necessary training, leadership, and experience for the substantial numbers who would be needed to meet the Navy's personnel requirements in the event of mobilization. Officer and enlisted women are now assigned within authorized allowances and are included within the total manpower personnel requirements. As a permanent part of the regular Navy and Naval Reserve, Navy women are no longer officially designated Waves, though the term *Waves* has been retained as a nickname.

In the not too distant past, it was believed women were only capable of filling the traditional personnel and administrative billets. Realizing the inequity of this belief, some changes have been instituted to consider women on an equal basis with their male counterparts (fig. 5-21). For example, women are now eligible to enter the Naval Academy and are accepted for flight

132.215

Figure 5-21.—Rear Admiral Fran McKee is the first woman unrestricted line officer promoted to flag rank in the U.S. Navy.

vident a single standard for men and women will volve.

VOMEN OFFICERS

To be eligible for appointment from civilian fe to officer candidate status, a woman must be U.S. citizen, hold a baccalaureate degree from n accredited university, and be between the ages f 19 and 27 1/2 at the time of commissioning. he may be single or married, and may have ependents under 18 years of age. She must meet ie mental, moral, and physical standards stablished by the Navy.

Women officer candidates attend Officer andidate School at Newport, Rhode Island, and articipate in an integrated 19-week curriculum ith male officer candidates. The curriculum is omposed of courses in leadership and management, discipline administration, material management (3M), personnel administration, naval arfare, seamanship, piloting, celestial navigation, ommunications, engineering, human resource anagement, and damage control.

Upon successful completion of OCS, the oman officer is commissioned an ensign in the nrestricted or restricted line or Supply Corps and as a 4-year obligation to complete. Women ommissioned in the Supply Corps receive a eriod of additional training at the Navy Supply orps School, Athens, Georgia. For her initial ssignment, she may be ordered to a 1-4 year tour duty within the continental U.S. or overseas. uring this period, she may apply for augmentaon to the regular Navy.

A woman officer is normally screened for ostgraduate education in the grade of lieutenant unior grade) or lieutenant. Women officers lected for postgraduate education participate the same programs as their male counterrts.

NLISTED WOMEN

To be eligible for enlistment in the Navy, a oman must be between the ages of 18 and 30, a high school graduate, and may be single or arried.

Some of the courses included in the 12-week training period are naval orientation, indoctrination in Navy ratings, ship and aircraft identification, naval history, fire fighting, and seamanship.

Enlisted women can strike for ratings based on the same criterion as men; there are, however, certain seagoing ratings which are closed to women due to legislation. The majority of recruit graduates are ordered directly to specialized schools for training in the ratings available to them.

Upon completion of training, enlisted women are assigned to naval activities throughout the world. In those assignments, they have demonstrated their ability to fulfill the requirements in billets once held exclusively by men (fig. 5-22). Some examples of these are aircraft

134.216

Figure 5-22.—An enlisted woman demonstrating her ability to fulfill the requirements of a billet once held exclusively by men.

mechanics, electricians, and machinists. This ability has brought about an expanded role for enlisted women in today's Navy.

THE UNITED STATES COAST GUARD

The United States Coast Guard has a dual role that is unique among the services. By statute, organization, and operation, the Coast Guard is a military service and a branch of the armed forces always, but normally it operates as a service in the Department of Transportation. In time of war or when the President so directs, it becomes a service in the Navy, but it continues to perform its normal specialized duties.

The Coast Guard is responsible for a large part of all federal operations connected with peacetime maritime activities. In time of war or other national emergency, these peacetime activities take on added importance because of the need for prompt and dependable movement of military personnel and supplies. The Coast Guard assists other government agencies in special undertakings and missions for which its personnel and facilities are especially qualified.

The Coast Guard maintains a state of military readiness so that it can operate immediately and effectively as a service of the Navy in time of war or when so directed by the President. To make such a transition with a minimum of friction, the Coast Guard's peacetime organization, regulations, training, and customs parallel those of the Navy insofar as operations permit. Personnel receive the same pay and allowances as prescribed for corresponding grades and rates in the Navy.

Whenever the Coast Guard operates as a service in the Navy, its personnel are subject to the laws prescribed for governing the Navy, and precedence between commissioned officers of corresponding grades of the two services is determined by date of rank.

Coast Guard officers and enlisted men are eligible to attend the various schools of instruction maintained by the Navy, Army, and Air Force.

Transfer without compensation of military stores, supplies, and equipment of every character is authorized between the Navy, Army, and Coast Guard. The Secretary of the Navy is authorized to build vessels for the Coast Guard at naval shipyards.

In 1967, the Coast Guard was removed from the Treasury Department (with which it had been associated since 1790) and placed in the newly created Department of Transportation. When operating in the Department of Transportation, the Commandant of the Coast Guard is responsible to the Secretary of Transportation. When operating in the Navy Department, the Commandant reports to the Secretary of the Navy and the Chief of Naval Operations.

FUNCTIONS OF THE COAST GUARD

The Coast Guard is the nation's foremost maritime safety and law enforcement agency in time of peace. A primary function is the enforcement of all applicable federal laws upon the high seas and in waters that are subject to the jurisdiction of the United States. This includes the administration of laws and the promulgation and enforcement of regulations for the promotion of safety of life and property, and covers all matters not specifically delegated by law to some other executive agency. Among the more important duties in this field are enforcement of the navigation and inspection laws, anchorage regulations, and laws relating to internal revenue, customs, immigration, neutrality, and conservation and protection of fisheries and wildlife, which require marine or aviation personnel and facilities for effective enforcement.

Port Security

Among the Coast Guard's major duties in the national defense program is port security—safeguarding against destruction or loss from sabotage or other subversive acts, all vessels, harbors, ports, and waterfront facilities in the United States and its territories. This duty includes prevention of illegal entry from the sea of persons or things inimical to the United States; supervision and control of the loading of explosives and other dangerous cargoes; security

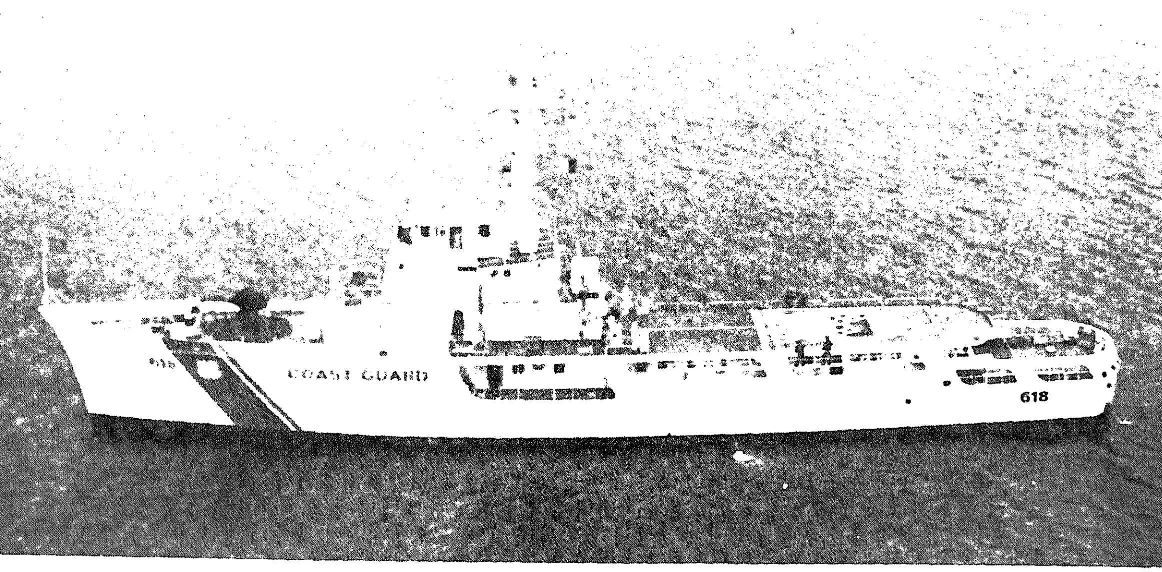

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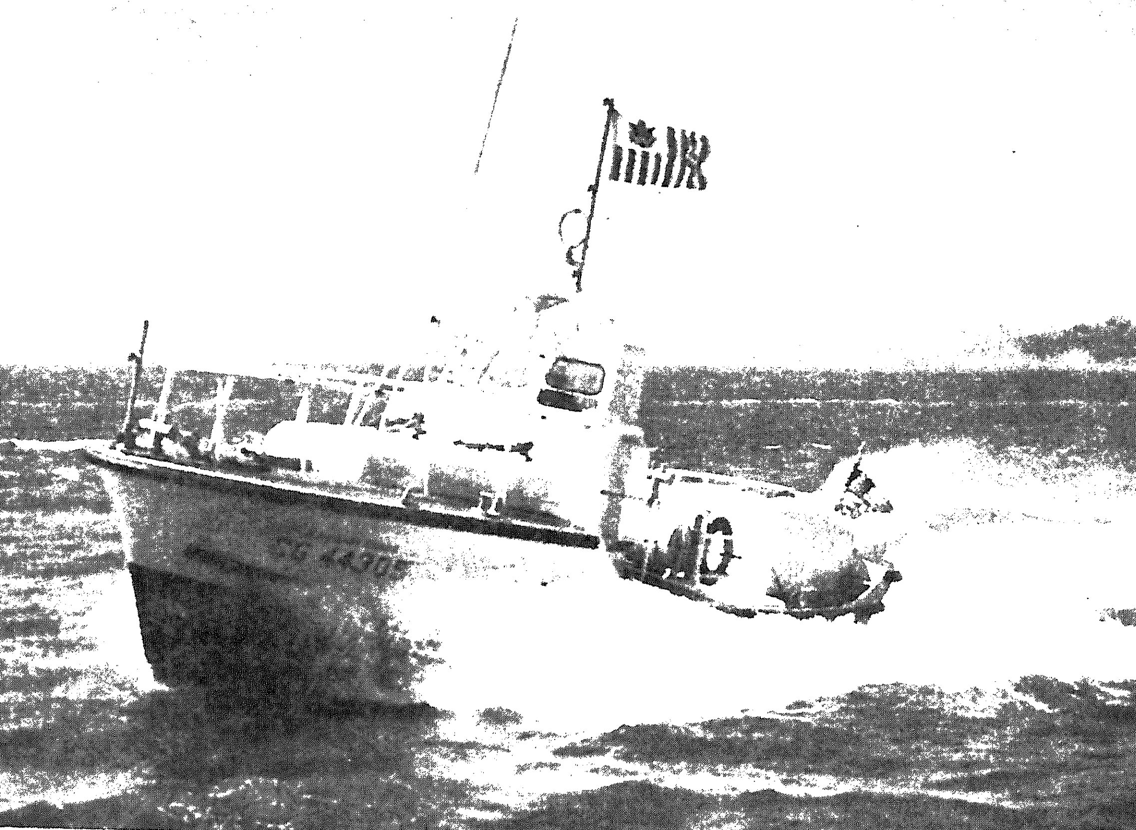
Figure 5-23.—Features of this medium-endurance cutter include a 3-inch gun and helicopter deck aft.



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5-24.—Among its many duties, the Coast Guard stands ready to rescue shipwrecked survivors. This

checks of merchant marine officers and crew members; security screening of waterfront workers to ensure that subversives and other undesirable persons are denied access to restricted waterfront areas and vessels; and patrolling approaches to principal harbors. Figure 5-23 is a class of medium-endurance cutter capable of cruising 5,000 miles at 15 knots.

Search and Rescue

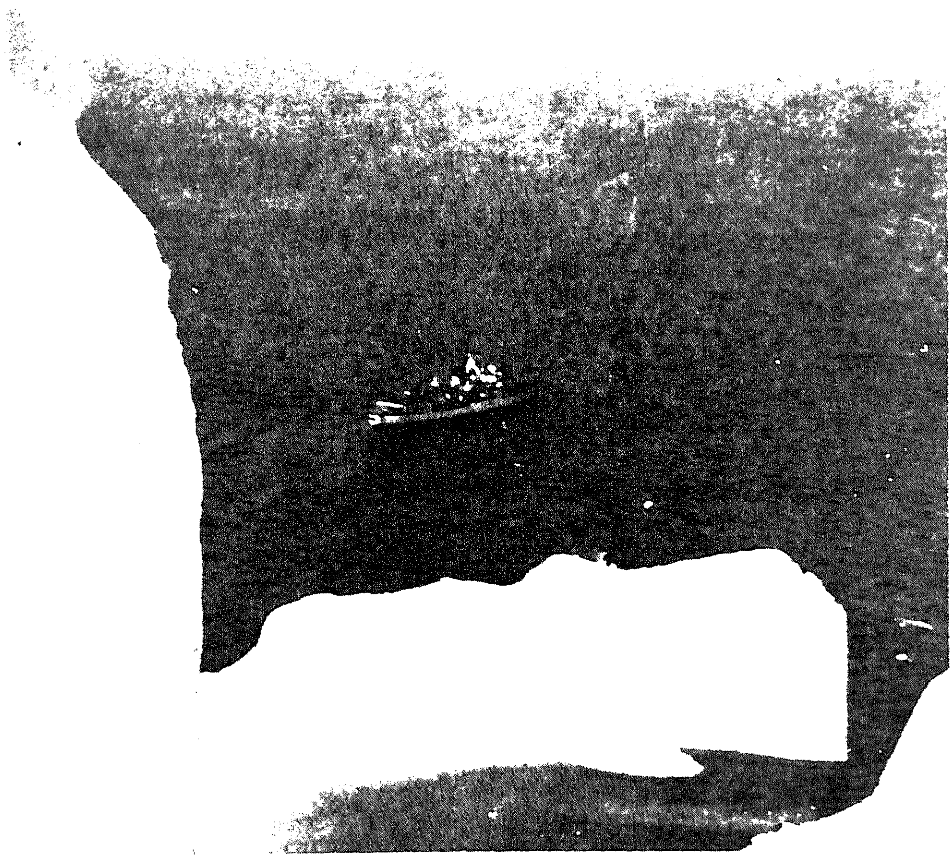
The Coast Guard maintains an established organization of inshore and offshore rescue surface ships, aircraft, lifeboat stations, and rescue coordination centers in each Coast Guard district. It extends medical aid to crews of vessels at sea, cares for and transports shipwrecked and destitute persons, and engages in flood relief work. Figure 5-24 shows a self-bailing, non-sinkable lifeboat used by USCG. In one recent year, the Coast Guard responded to 70,000 calls for assistance with about 4,200 persons saved from death; more than 140,000 other persons were aided, and $280,000,000 worth of property was saved.

Icebreaking and Ice Patrol

The Coast Guard removes or destroys derelicts, wrecks, and other dangers to navigation and, with its icebreaking facilities, assists marine commerce by opening ice-blocked channels and ports. It conducts the International Ice Patrol in the North Atlantic (fig. 5-25) to protect shipping from the danger of icebergs, and carries out oceanographic studies.

Ocean Stations

The Coast Guard operates and maintains ocean stations in the North Atlantic and North Pacific. The funtion of an ocean station is to



134.53

Figure 5-25.—Infesting arctic waters, monster chunks of ice await unsuspecting ships. The SS Titanic ripped out her bottom on an underwater iceberg crag in 1912 with the loss of 1,500 people. To prevent a recurrence of that disaster, U.S. Coast Guard ships and aircraft of the International Ice Patrol search through the cold and fog to locate and track icebergs.

rovide, in addition to meteorological services in ocean areas regularly traversed by ships and ircraft, search and rescue, communication, and ir navigation facilities.

Ierchant Marine Safety

Functions of the Coast Guard that relate o the merchant marine include the following: ivestigation of marine disasters and collection f statistics relating to such disasters; approval f plans for construction, repair, and alteration f vessels; issuance of certificates of inspection nd permits indicating approval of ships for perations that may be hazardous to life and roperty; regulation of the transportation of xplosives and other dangerous articles on vessels; icensing and certificating of officers, pilots, and eamen; enforcement of manning requirements or the mustering and drilling of crews; suspension nd revocation of licenses and certificates; icensing of motorboat operators; shipment, ischarge, protection, and welfare of merchant eamen; and the promulgation and enforcement f rules for lights, signals, speed, steering, ailing, passing, anchorage, movement, and owlines of vessels.

ids to Navigation

The Coast Guard establishes and maintains narine aids to navigation, such as lighthouses, ghts, radio beacons, radio direction-finder tations, buoys, unlighted beacons, and VTS vessel traffic services), as required to serve the eeds of commerce and of the armed forces. It naintains the United States system of loran (long-ange aid to navigation) to serve the needs of the rmed forces, mariners, and maritime airborne ommerce.

The Coast Guard maintains about 40,000 aids o navigation in the United States, its territories nd possessions, the Trust Territory of the Pacific slands, and at overseas military bases. These aids nclude some 60 loran stations, 350 manned light tations, and 30 offshore light structures.

Iarine Environmental Protection

Although the Coast Guard has been enforcing ur fisheries laws since 1793 to conserve marine fe, the increased pollution in and near our coastal aters required increased surveillance and new echniques to combat this serious threat to our narine environment. With the enactment of the Federal Water Pollution Control Act of 1972, a National Strike Force (NSF) was formed. This force consists of three 18-man teams, one each on the Pacific, Atlantic, and Gulf Coast, composed of people who are specially trained and equipped for antipollution work. Not only are these teams capable of handling domestic problems, but they can also be deployed at a moment's notice anywhere in the world when the need arises.

ORGANIZATION OF THE COAST GUARD

The Commandant of the Coast Guard is the chief of the service and its senior officer, with the rank of admiral. He is appointed by the President for a term of 4 years, from the active list of line officers who hold a permanent commission as commander or above and who have completed at least 10 years' service as commissioned officers in the Coast Guard. From the Coast Guard Headquarters in Washington, the Commandant directs the policy, legislation, and administrative affairs of the service, under the general supervision of the Secretary of Transportation.

The basic organization pattern of the Coast Guard reflects an assignment of military command and operational and administrative responsibility and authority among components in Headquarters, in district offices, and in individual units in the field. Duties of the Coast Guard, in most instances, actually are performed by individual operating units, such as ships and aircraft; air, light, radio, and lifeboat stations; marine inspection offices; and individual logistic units, such as recruiting, receiving, and training stations, bases, depots, and repair shops.

HISTORY AND ACCOMPLISHMENTS OF THE COAST GUARD

Created by Act of Congress on 4 August 1790, at the request of the first Secretary of the Treasury, Alexander Hamilton, as a seagoing service of 10 boats to be employed "for the security of the revenue," the Coast Guard was variously known by such names as the Revenue Marine, Revenue Service, and Revenue Cutter Service. As early as 1799, Congress provided that the cutters should, whenever the President directed, cooperate with the Navy. On 28 January 1915, the President signed a law consolidating the Life Saving Service and the Revenue Cutter Service, both of the Treasury Department, into

a single service of the Treasury under the name of the Coast Guard.

Early accomplishments. The early Revenue Marine found itself invested with many other duties besides enforcing the revenue laws. The enforcement of state quarantine statutes, the suppression of piracy and the slave trade, and the enforcement of neutrality laws and immigration laws were included in its manifold undertakings.

In 1798 eight vessels of the Revenue Marine were assigned to cooperate with the newly organized Navy in the quasi war with France.

To enforce President Jefferson's 1807 embargo, 12 new vessels were authorized in 1809, and these helped to carry the naval burden in the War of 1812. In this war, the Revenue Marine helped to protect our coastal trade by providing convoy between ports. It attacked or warded off attacks of privateers and armed flotillas sent out by British squadrons ranging freely along our coasts, and it captured hostile armed merchantmen.

When the Seminole War broke out in 1836, eight revenue cutters cooperated with the Army and Navy in blockading rivers, carrying dispatches, transporting troops and ammunition, and providing landing parties for the defense of settlements menaced by the Indians.

Eleven cutters participated in the Mexican War from 1846 to 1848, principally in cooperation with the armies under Taylor and Scott.

In 1849, Captain Frazer, the first military commandant, found San Francisco a difficult station with the inrush of the gold-seeking 49'ers. There were some 600 vessels riding at anchor, many with insubordinate lawless crews. As yet there were no civil tribunals, and Captain Frazer and his aides worked day and night enforcing the revenue laws and helping shipmasters suppress mutiny and violence.

Lifesaving Service. One of the Coast Guard's major activities has always been the assisting of vessels in distress and the saving of life and property at sea. Andrew Jackson's Secretary of the Treasury first designated the Revenue Marine for this duty in 1831 when he detailed seven cutters to patrol areas near their stations and perform such functions. The first appropriation for saving life from shore was made by Congress in 1847. By 1847 there were lifesaving stations at many points along the coast of New England, the South Atlantic and Pacific coasts, and the Great Lakes. Lifesaving medals were authorized, personnel matters reorganized, beach patrols and signals introduced, and the technique of us
breeches buoy developed.

In 1854 the Life Saving Service ha
established as a separate bureau of the Tr
Officers of the Revenue Cutter Servic
assigned to inspect, drill, and discipline th
of the lifesaving stations. Through the co
efforts of the two services, over 200,000 li
more than a billion dollars worth of proper
saved in the years between 1871 and 19

The Civil War. The revenue cutter
Lane, one of a group of ships sent to th
of Federal forces at Fort Sumter, was
during the bombardment of that fort. Jus
to the bombardment, *Harriet Lane* hai
steamer *Nashville* to show her colors.
Nashville failed to do so, *Harriet Lane* fire
across her bow and is credited with firing t
shot from any vessel during the Civil W

The *Miami* was Lincoln's personal tr
from which he landed to reconnoiter o
federate soil the night before the capt
Norfolk. Other cutters rendered im
services in the waters of North Caroli
cooperated with the naval forces in the g
flotilla in the Chesapeake.

Activities from 1867 to 1917. The r
cutter *Lincoln* was the first American
explore Alaskan waters following our p
of that territory from Russia in 1867. Fr
beginning, Alaska was the particular respo
of the Coast Guard. Its cutters were in A
waters from early May until late Decemb
year, rendering aid to shipping, cari
the shipwrecked, and assisting the
Public health surgeons detailed to the cu
the Alaska Patrol prescribed for and ai
sick.

Organized training was initiated in 1
that year, Congress provided for the appoi
of cadets to fill the lower commissioned
and the first training ship, *Dobbin*, was o
as a floating school of instruction.

In cooperation with the Navy, 13 cutte
part in the Spanish-American War; 8 we
Sampson's fleet on the Havana blockade
with Dewey's fleet, and 4 worked with th
on the Pacific coast.

Following the sinking of the *Tita*
collision with an iceberg, the Internatio
Patrol was initiated by the United States i
Its purpose is to locate icebergs and fi
nearest to transatlantic lanes of ocean tra
to warn ships of their locations. The patr
conducts oceanographic research.

Coast Guard in World War I. On 6 April 917, when we declared war on Germany, the Navy was augmented by 15 cruising cutters, over 00 commissioned officers, and 5,000 warrant fficers and enlisted men of the Coast Guard. They were entrusted with the hunting of sub-narines and raiders and with guarding the ransport of troops. A squadron of Coast Guard utters, based at Gibraltar, performed escort uty between that port and the British Isles. The utter *Tampa*, bound for Milford Haven after scorting a convoy to Gibraltar, disappeared uring a storm on the night of 26 September 1918, eaving no trace other than some floating 'reckage. Over 100 coastguardsmen were among ne 130 persons lost. In proportion to its strength, ne Coast Guard suffered the highest losses of any f the armed services in World War I.

Development between wars. Following World Var I, the experiment of prohibition added many roblems to the Coast Guard's work of preventing muggling. Enforcement of the prohibition law vas unpleasant and often dangerous, but funds vere allotted for expansion to an extent never efore equalled. The service was augmented and reatly improved, especially in the fields of ommunications and intelligence.

In 1932 the Coast Guard Academy was stablished on the Thames River at New London, Connecticut.

On 1 July 1939, the Lighthouse Service of the Department of Commerce was transferred to the Coast Guard. Its functions are the construction, peration, maintenance, repair, illumination, and ıspection of all aids to navigation, including ghthouses, lightships, buoys, beacons, fog gnals, and daymarks.

In 1939 Congress created the Auxiliary. This as a voluntary, nonmilitary organization of vilians intended to train and instruct those sing the high seas and navigable waters of the nited States. Another purpose was to secure the ooperation of yachtsmen and other small-boat wners in the observance of the laws and the doption of safety devices on their boats. Later, me 3,000 of these members of the Auxiliary with eir boats became available as "coastal pickets" hen enemy submarines began to prey on our oastal shipping.

The purpose of the Auxiliary today is to assist e Coast Guard in promoting marine safety and fecting rescues; in promoting efficiency in the peration of motorboats and yachts; in fostering wider knowledge of, and better compliance ith, all regulations governing the operation of motorboats and yachts; and in facilitating the operations of the Coast Guard.

When the President proclaimed our neutrality on 5 September 1939 in the war that had broken out in Europe, the Coast Guard assumed a wide field of responsibility in the prevention of unneutral acts by merchant vessels. A systematic and extensive patrol by aircraft, vessels, and coastal stations was carried out all along our coasts. Radio apparatus aboard merchant vessels of belligerent nations, while within our waters, was inspected and sealed.

On 27 June 1940, the President invoked by proclamation and delegated to the Secretary of the Treasury his powers under the Espionage Act of 1917. These powers included the right to govern the anchorage and movement of all vessels in United States waters; to inspect them and place guards on them; to take full possession and control of them, removing the officers and crew and all other persons not specifically authorized by him to go or remain on board; to secure them from danger or injury; and to prevent damage to harbors and waters of the United States. Shortly afterward, the Dangerous Cargo Act gave the Coast Guard, jointly with the Bureau of Marine Inspection and Navigation of the Department of Commerce, wide jurisdiction over every vessel on the navigable waters of the United States carrying specified high explosives or other dangerous cargo. This marked the beginning of the Coast Guard's wartime port security activities designed to protect navigable waterfront property and shipping.

The Coast Guard Reserve Act of 1941 established the Coast Guard Reserve, which, during the war years, grew to a considerable size. Numerous volunteer port security forces were organized by using temporary members of the Reserve in all the major ports to guard wharves, shipyards, and waterfront property on a part-time basis and with all services donated to the government.

On 1 November 1941, the entire Coast Guard was ordered to operate as part of the Navy. Coast Guard districts automatically went under control of the naval districts in which they were located. On 30 March 1942, the Coast Guard was designated as a service of the Navy Department, to be administered by the Commandant of the Coast Guard under the Secretary of the Navy, in accordance with general directives issued by the Commander in Chief (the President), the Secretary of the Navy, and the Chief of Naval Operations. Before the declaration of war, the

larger cutters and patrol boats capable of offshore operations had been assigned to the fleet, to sea frontiers, or task forces for convoy, antisubmarine, and patrol duty.

Coast Guard in World War II. Shortly after the declaration of war on 8 December 1941, Coast Guard vessels got into action. On 9 May 1942, the cutter *Icarus* sank a German U-boat and took 33 prisoners, including the submarine's commanding officer. The cutter *Campbell* was the next Coast Guard vessel to register a definite kill in the gruelling antisubmarine war. Postwar investigation confirmed the sinkings by Coast Guard vessels of seven enemy submarines.

The Coast Guard acquired a number of civilian craft, including sailboats as well as powerboats, that were capable of remaining at sea for at least 48 hours. Some carried depth charges and were armed with machine guns; all were equipped with radios. They functioned as coastal pickets, and their duties were to observe and report actions of all hostile submarines, surface craft, air forces, and to attack and destroy when their armament permitted. They also conducted rescue operations offshore.

New scientific developments aided the Coast Guard in performing wartime duties. In addition to loran and radar, racon and anrac were utilized. Racon, a fixed frequency transponder that gives distance and bearing within 120 miles of a plane or ship, can be used for coastwise piloting in peace. Anrac is a form of remote radio control employed to light and extinguish electrically lighted unattended beacons and operate fog signals.

During 1942 Coast Guard vessels of 65 feet or longer increased in number from 3,732 to 8,357. This expanded fleet, together with the Coast Guard's regular cutters, brought in over 1,500 survivors of enemy torpedoings along the Atlantic Coast, Gulf of Mexico, and in the Caribbean. They were assisted by Coast Guard planes, which numbered around 200 during the war. Lifeboat stations along the Atlantic Coast picked up hundreds of survivors in lifeboats after they had been spotted by Coast Guard aircraft on antisubmarine patrols off the coasts. The planes guided fishing vessels and other craft to submarine victims in the water. As the submarine menace along our coasts subsided, most of the 24,000 coastguardsmen that had been patrolling 40,000 miles of our coast were released for sea duty. Temporary reservists and SPARS (the Coast Guard's counterpart to the WAVES) relieved many others for more active service in the frontline of amphibious and antisubmari[ne] attack.

A total of 351 Navy vessels were manned [by] coastguardsmen. These included destroyer escor[ts,] troop transports, cargo vessels, tankers, landi[ng] craft, and a variety of patrol craft. In additio[n,] many other types of Navy ships had coastguar[ds]men in their crews. The Coast Guard also mann[ed] 291 Army vessels, including freight and supp[ly] vessels, large tugs, tankers, and freight boa[ts] which constituted supply echelons for Southwe[st] Pacific and Philippine Army bases. Out of a to[tal] of 1,035 coastguardsmen who died aboard shi[ps,] 572 were killed in action. Altogether, over 1,8[..] Coast Guard personnel died in the war.

Return to peacetime duties. Following Wor[ld] War II, the Coast Guard was demobilized un[til] it reached a low of 18,687 officers and men [in] 1947. The Korean conflict, commencing in Ju[ne] 1950, had tremendous impact on the Coast Gua[rd] even though it was not transferred to the Na[vy] as in previous emergencies.

The impact of defense mobilization w[as] reflected in added operational demands for [all] phases of the peacetime missions of the Coa[st] Guard. Presidential Executive Order 101[..] instituted a port program designed to prote[ct] ships, harbors, ports, and waterfront faciliti[es.] To carry out the program, the Coast Gua[rd] assigned Captains of the Port to all maj[or] cities.

The Coast Guard operated five weath[er] stations in the Pacific during the conflict [to] provide more reliable weather data, and a numb[er] of loran (long-range aids to navigation) tra[ns]mitting stations were built to provide better sh[ip] and aircraft navigation in the area.

Faced with a problem of enemy infiltrati[on] along the long, irregular coastline of the Repub[lic] of Vietnam in 1965, the Navy turned to the Coa[st] Guard for assistance. Highly maneuverable Coa[st] Guard 82-foot patrol craft were determined to [be] the best vessels for use in combating the Viet Co[ng] infiltrators, so 17 heavily armed cutters were se[nt] to Vietnam to form the backbone of the Navy['s] operation "Market Time."

An additional 9 cutters were later sent [to] Vietnam, and the 26 vessels were divided into [..] squadrons that patrolled the entire coast, boar[d]ing suspicious vessels and searching for weapo[ns,] ammunition, and other contraband.

A major encounter with the enemy took pla[ce] in May 1966, when the cutter *Point Grey* spott[ed] two bonfires on the beach, which appeared to [be] signals for infiltrators. The *Point Grey* waited

darkness for the enemy to make a move, and after making radar contact with an unidentified vessel, the cutter went into action and forced it aground.

The enemy ship, a 125-foot trawler, was ripped apart by the *Point Grey* and other cutters and aircraft. Salvage crews later removed 15 tons of weapons and ammunition from her charred and broken hull.

In mid-1967, in response to a Navy request, the Coast Guard sent five of its larger cutters into action to strengthen Vietnam coastal defenses. By the end of the conflict, nearly all major Coast Guard cutters had been on a Vietnam deployment.

On April 1, 1967, after nearly 177 years in the Treasury Department, the Coast Guard was transferred to the new Department of Transportation (DOT).

The Coast Guard today is always mindful that it is a branch of the armed forces. Units and personnel are trained to meet or exceed Navy fleet performance standards. Energy restrictions during 1974 curtailed Navy refresher training for 45 cutters, but particular emphasis was placed on refresher training for the crew of high-endurance cutters. Present policy calls for all cutters of the 378-foot *Hamilton* class to undergo four weeks of training annually.

The Coast Guard today. Today's peacetime Coast Guard is adding exciting new pages to its history almost daily in search and rescue missions, prevention and cleanup of pollution, by fighting crime on the high seas, and in the protection of U.S. fisheries.

The numerous missions of the Coast Guard are carried out by 37,000 military and 6,000 civilian personnel. From scattered bases, they operate a fleet of 250 ships, 160 aircraft, and more than 2,000 small craft. They also maintain more than 45,000 aids to navigation. Others are busy ensuring the safety of the merchant marine, recreational boaters, and the nation's bridges. America's entire icebreaking fleet, which operates in the Arctic, antarctic, and on the Great Lakes during the winter season, flies the Coast Guard ensign.

More than 11,700 Coast Guard reservists augment regular forces in peak periods and emergency situations. Last year reservists provided approximately 2.8 million man-hours of support to the regular Coast Guard. Additionally, 45,000 citizen volunteers of the Coast Guard Auxiliary lend valuable assistance to the Coast Guard.

The prevention of smuggling, another duty that dates back to the Coast Guard's earliest days, is still a major mission and very much in the limelight. Coast Guard forces are extensively involved in the Gulf of Mexico and the Caribbean assisting the Drug Enforcement Agency and the Bureau of Customs in operations designed to stem the flow of narcotics into the country.

In addition to these traditional assignments, the Coast Guard has recently undertaken major new missions, especially in the area of environmental protection. Three strategically located strike teams respond to about 60 major pollution incidents each year.

Looking to the future, the Coast Guard is planning for increased offshore law-enforcement patrols with the enactment of the 200-mile maritime economic zone. The new zone will equal about one-third the size of the nation.

CHAPTER 6

UNDERWAY REPLENISHMENT

Navy ships must often remain at sea for long periods of time. In wartime the fleet usually will operate far from bases of support, necessitating some means of resupplying the ships so that they remain fully capable of carrying out the Navy's mission and other assigned tasks. This broad operational requirement is met by means of underway replenishment (UNREP). Even in peacetime the Navy's ability to maintain a fleet overseas is of great importance. The Sixth Fleet, for example, has been maintained in the Mediterranean Sea for many years almost solely by UNREP operations.

Underway replenishment is the term applied to all methods of transferring fuel, munitions, supplies, and personnel from one vessel to another while the ships are underway. Two general methods are used: connected and vertical. Both methods may be used simultaneously.

In the connected (CONREP) method, transfers of personnel and all commodities are accomplished by means of lines and hoses rigged between the ships. The vertical replenishment method, called VERTREP, employs helicopters to transfer personnel and cargo (except fuel). Transferring fuel is referred to as fueling (or refueling) at sea (FAS). Transferring cargo is called replenishment at sea (RAS).

REPLENISHMENT SHIPS

A variety of vessel types are employed as underway replenishment ships. Some are single-product vessels that carry only one primary commodity, such as oil. Others are multiproduct types that can supply fuel, ammunition, and general cargo. The great advantage of the latter type is that the ship being replenished need make only one stop alongside the replenishing ship, thus eliminating the necessity of going alongside an oiler, then an ammunition ship, then a stores ship, and so on. The multiproduct ships themselves are replenished by single-product types.

Large combatants, such as aircraft carrier usually refuel (top off) escorting vessels period cally in between their scheduled replenishment This practice maintains the force at a uniform high level of operational readiness and serves insurance against possible delays of schedule FAS because of adverse weather.

An example of continuing efforts to impro logistic support of the fleet is the mini-mul concept, whereby a single-product ship is modifie to provide a limited multiproduct capabilit Ammunition ships in particular have been use in this new role. Holds have been modified carry dry stores and increased fuel cargo an have been fitted with portable reefer boxes. Thu ammunition ships can support a small for engaged in distant operations. This was done f a destroyer unit during an Indian Ocean deplo ment. Another example is that all Pacific Fle Mobile Logistic Support force nonoilers have be fitted with fuel delivery rigs.

AMMUNITION SHIPS (AE)

Ammunition ships (figure 6-1) deliver am munition, bombs, and missiles. Ships of t *Kilauea* (AE-26) class are 564 feet in length, wi a beam of 81 feet and a draft of 30 feet. Displac ment is about 20,000 tons. AEs also have a limit dry cargo capability.

Their cargo handling systems include du cantilevered elevators in the holds, forklift truck and low-lift power-operated transporters f handling palletized ammunition from the elevato to the transfer stations. A tensioned highli system with improved electrohydraulic carg winches provides rapid and reliable transfer Ammunition ships also operate helicopters f VERTREP operations.

OILERS (AO)

An oiler furnishes complete replenishment petroleum products and can carry some fle

freight. Ships of the *Neosho* class (figure 6-2) displace about 40,000 tons, are 655 feet long, 86 feet in the beam, and have a draft of 36 feet. Cargo capacity is over 150,000 barrels of fuel oil, aviation gasoline, and JP-5 in varying mixes.

Some older AOs have been "jumboized" by adding a section amidships, increasing their cargo capacity by about one third.

FAST COMBAT SUPPORT SHIP (AOE)

The largest auxiliary in the Navy is the fast combat support ship. With a full-load displacement of 52,000 tons, a beam of over 100 feet, and a length of nearly 800 feet, the AOE is larger than most of our World War II battleships (figure 6-3). The AOE is a multiproduct ship designed to simultaneously deliver fuel, munitions, and provisions to carriers and their escorts. The cargo handling equipment is highly automated, and two helicopters are carried for VERTREP operations.

REPLENISHMENT OILER (AOR)

Replenishment oilers are similar in mission and appearance to the AOE. They are somewhat smaller, displacing 38,000 tons and have a beam of 96 feet and a length of 660 feet. These ships

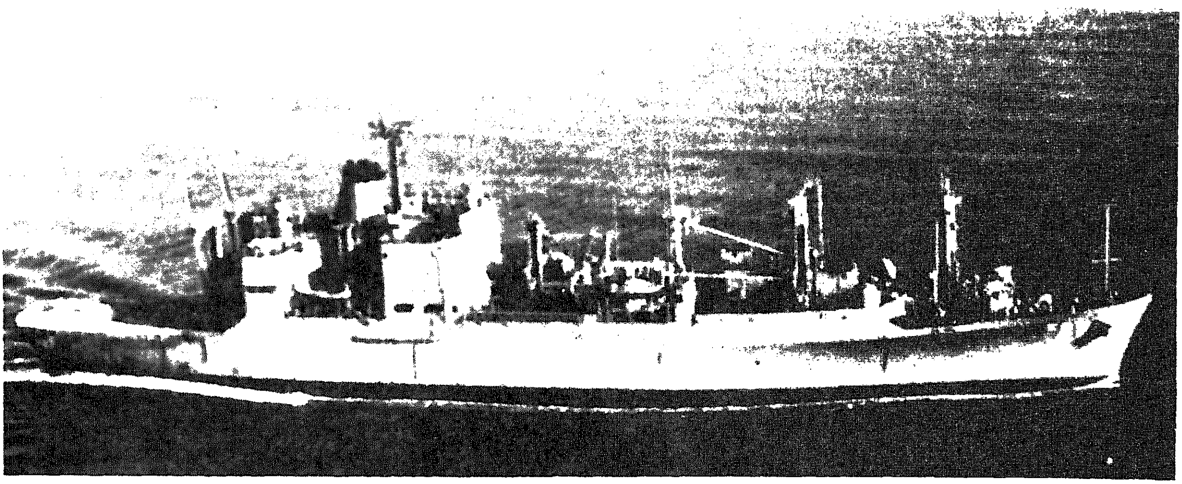


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Figure 6-1.—USS Butte (AE-27).

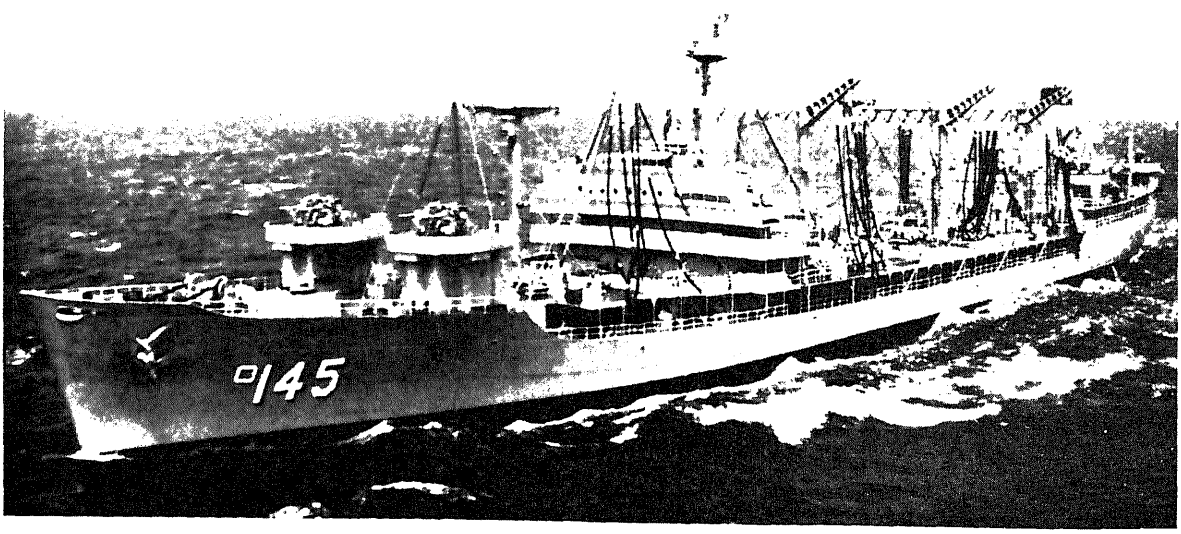

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Figure 6-2.—USNS Hassayampa (TAO-145).

carry petroleum and munitions and have a limited capacity for dry and frozen provisions.

COMBAT STORES SHIP (AFS)

The combat stores ship (figure 6-4) provides the logistic capability of a cargo ship (AK) and refrigerated provisions ship (AF), along with aviation and other technical spares. Its replenishment rigs provide for ship separation out to 200 feet. This reduces the possibility of collision and of parting the rigs, thus enhancing personnel safety.

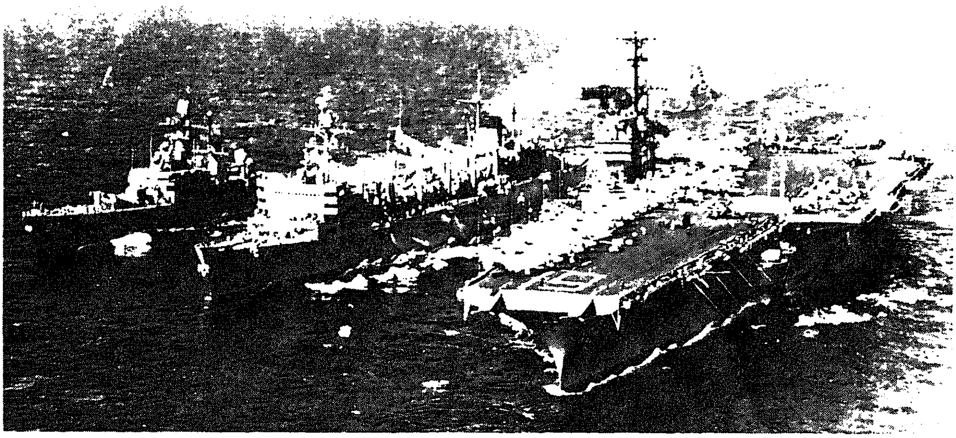

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Figure 6-3.—An AOE replenishing two ships.

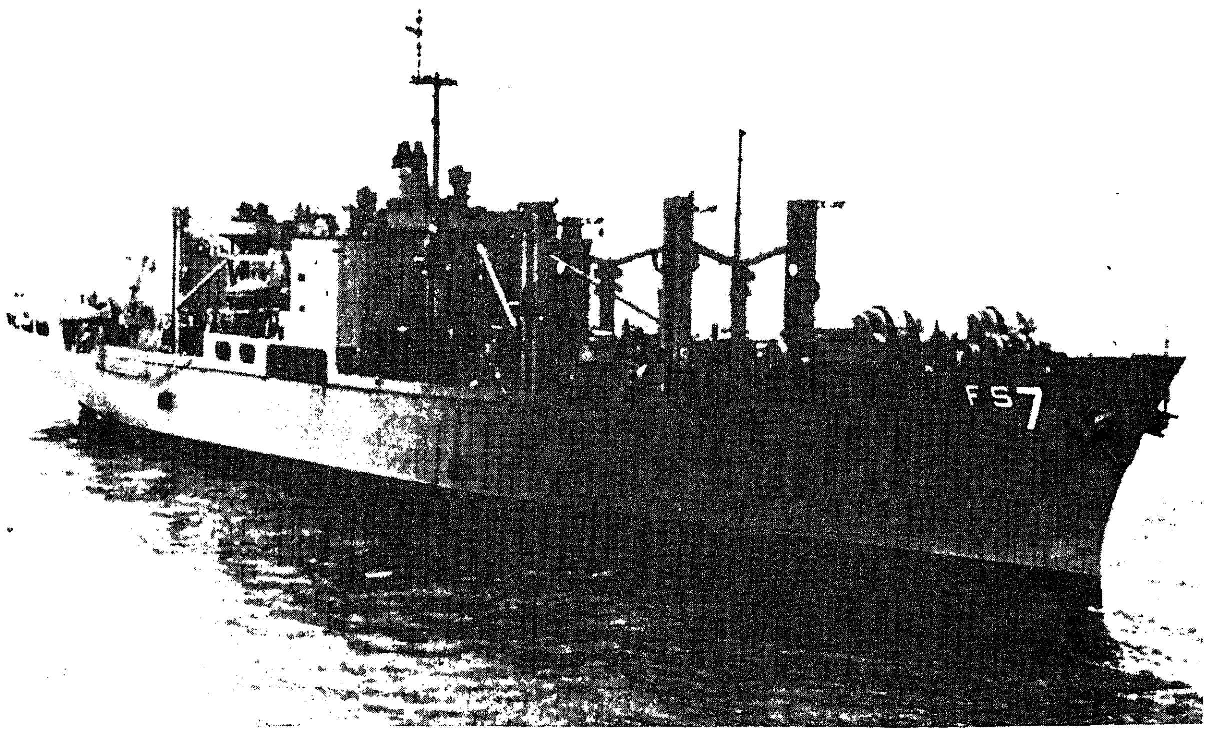

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Figure 6-4.—USS San Jose (AFS 7).

Many former naval auxiliaries are now manned by Military Sealift Command (MSC) personnel. They are identified by the letter "T" as a prefix to their type classification (for example, T-AF, T-AO) and are designated USNS vice USS. Fleet units often are replenished by MSC vessels.

COMMON REPLENISHMENT FEATURES

Many features are common to several replenishment operations (except VERTREP). Some, such as shiphandling and safety precautions, are discussed later in the chapter. Others, such as distance lines and night lighting, are discussed in this section. Before proceeding to those, however, clarification of some terms is in order.

The replenishment units are the delivery ship, which furnishes and handles the rigs, and the receiving ship, which receives the rigs. (Unless noted otherwise, the receiving ship is the one being replenished.)

The delivery ship normally is the control ship, which maintains replenishment course and speed. The receiving ship usually is the approach ship, which maintains station alongside the control ship. Their actions and responsibilities are discussed later.

PHONE/DISTANCE LINES

A bridge-to-bridge (B/B) combination phone/distance line provides both a sound-powered (S/P) telephone circuit and a visual indication of the distance between ships. The line is passed and tended by the receiving ship. The usual procedure is for the delivery ship to send over a messenger, the receiving ship attaches

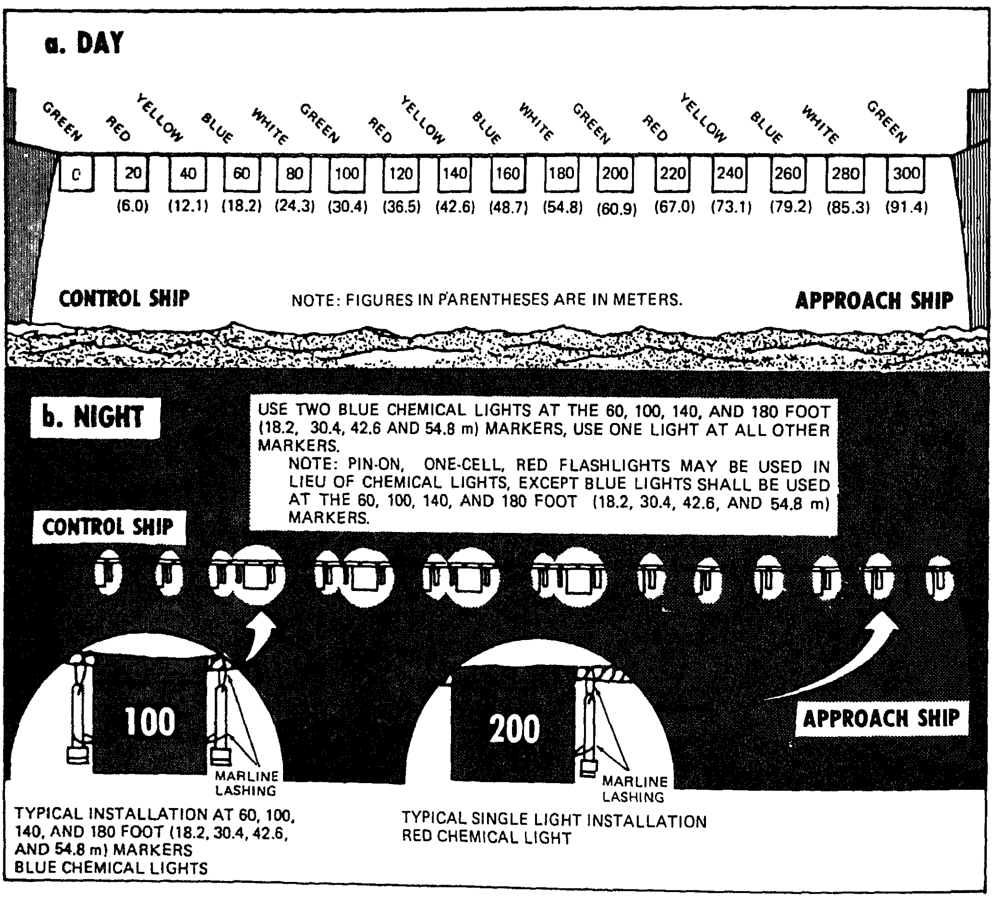

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Figure 6-5.—B/B phone/distance line markings.

the zero end of the phone/distance line to the messenger, and the delivery ship hauls in the line and secures the zero end to the outermost rail. On the receiving ship and in view of the conning officer, the S/P talker hand tends the line, keeping it taut and at right angles between the ships. The neck strap of the telephone headset should never be worn by the talker. At night the tender keeps the conning officer informed of the distance.

The distance line is marked as indicated in figure 6-5. The markers are 8 by 10 inches with 5-inch numerals. Lights are either one-cell pin-on flashlights or chemical lights.

Each transfer station has a station-to-station (sta/sta) S/P phone line. The delivery ship normally provides these lines.

TRANSFER STATION MARKINGS

At each replenishment station both ships indicate the commodity being handled. By day this information is conveyed by painted area markers; light boxes are used at night. The code for indicating commodities is shown in figure 6-6.

COMMODITY TRANSFERRED	CODE: DAY 3-FT. SQ. BUNTING OR PAINTED AREA	CODE: NIGHT LIGHT BOX
MISSILES	INTERNATIONAL ORANGE	
AMMUNITION	GREEN	
FUEL OIL	RED	
DIESEL OIL	BLUE	
NAVY DISTILLATE (ND)	RED & BLUE TRIANGLES	
AVGAS	YELLOW	
JET FUEL (JP-5)	YELLOW & BLUE TRIANGLES	
WATER	WHITE	
STORES	GREEN WITH WHITE VERTICAL STRIPES	
PERSONNEL AND/ OR LIGHT FREIGHT	GREEN WITH WHITE LETTER "P" CENTERED	
FUEL OIL AND JP-5	RED/YELLOW & BLUE TRIANGLES	
ND AND JP5	RED/BLUE & YELLOW/ BLUE TRIANGLES	

37.14

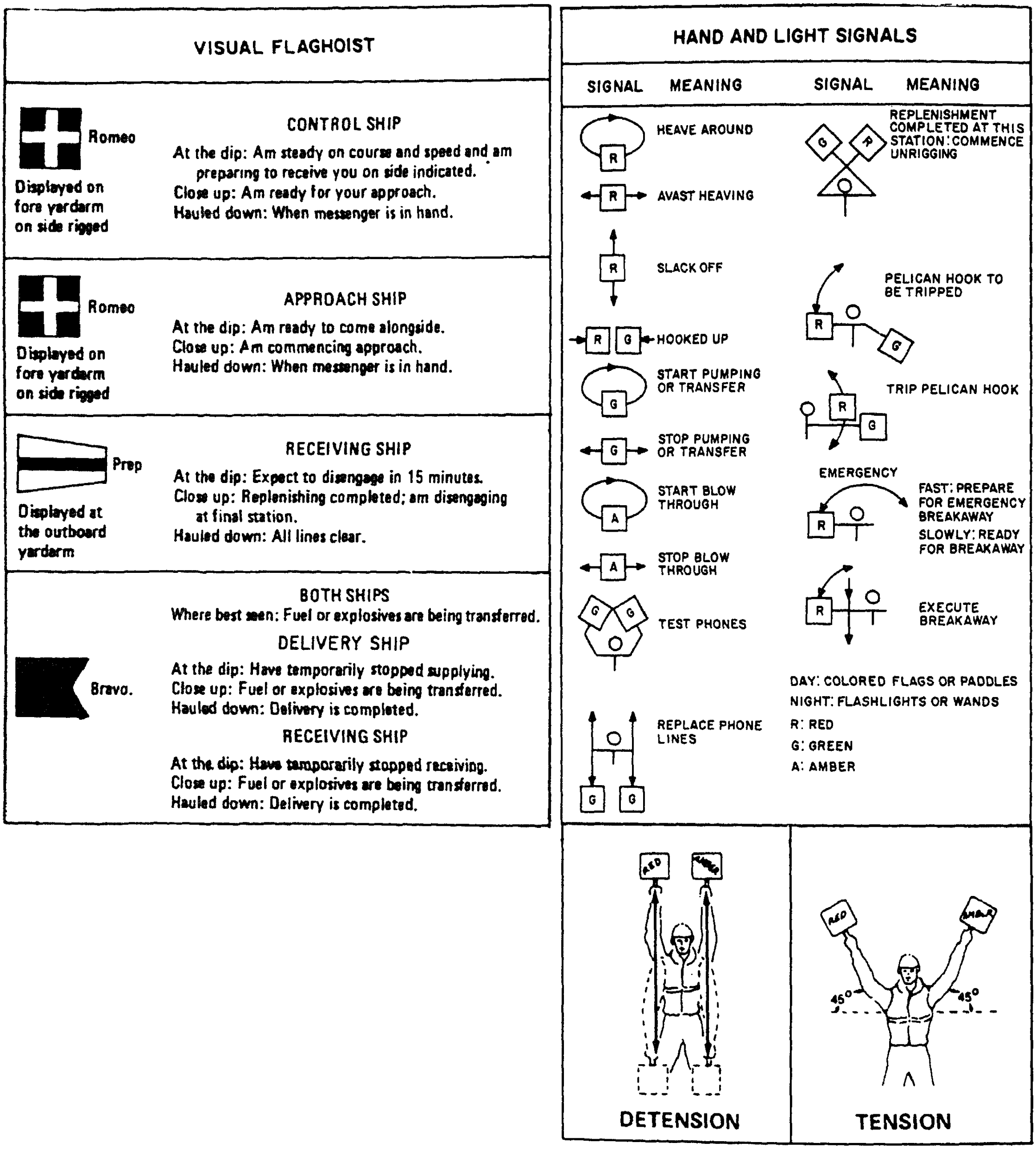
Figure 6-6.—Day and night markers for transfer stations.

SIGNALS

Hand signals are used to parallel orders passed over S/P sta/sta phones. During the day, 12-inch by 12-inch colored paddles are used; colored wands or flashlights are used at night.

Each ship signals the action it desires to be taken by the other ship; for example, the receiving ship signals the delivery ship to start pumping oil. If the other ship cannot comply, it initiates the avast signal, which is repeated by the first ship. The ship initiating an avast signal must originate the next signal. Hand signals are shown in figure 6-7.

In addition to lights and shapes required by the Navigation Rules of the Road, replenishment ships display the flaghoist signals shown in figure 6-7.



NIGHT LIGHTING

Lighting for night replenishment must be sufficient to permit safe operations, but white lights that interfere with the night vision of bridge personnel and pilots cannot be permitted. In fact, a darkened ship is the normal lighting condition. Area, rig, obstruction, and identifying lights are red. Green and amber lights are used by station signalmen.

All prominent points of the transfer rigging (hose saddles, trolleys, couplings blocks, and so on) are marked with red lights. The number of lights varies with the fitting, from one on a messenger to eight on a personnel transfer chair. Working areas are illuminated by low-intensity floodlights.

Six red lights horizontally spaced 2 feet apart mark the deck edge or height of the highest obstruction outboard of each receiving station landing or working area. The corners of deck edge elevators, torpedo and gun mounts, and similar fixtures are marked with one red light. Vertical obstructions (stanchions, boom guys, preventer wires, and so on) that limit the receiving ship's open working area are marked with three red lights vertically spaced 3 inches apart. Any outboard obstruction that might be a hazard to an approaching ship, such as a gun sponson, is marked with red lights.

Approach and station-keeping lights on the delivery ship are shown in figure 6-8. Two blue contour lights are located at the fore and aft extremes of the side that are parallel to the keel. Ships over 600 feet long show a third light midway between the other two. The control ship uses a shielded directional signal light to indicate ROMEO close-up.

REPLENISHMENT RIGS

Various types of rigs may be used for transferring cargo between ships. Each has its advantages and disadvantages in relation to the size, structure, and rigging potential of the ships involved. The method to be used for a particular replenishment operation is selected on the basis of—

1. Type and quantity of cargo
2. Capacity of the rig and associated fittings
3. Weight and size of the heaviest or largest load
4. Type and location of receiving station
5. Weather and sea conditions

Several different rigs are described, but no details are given concerning actual rigging procedures since such information is beyond the scope of this text. Complete details may be found in NWP 14, *Replenishment At Sea*.

WIRE HIGHLINE

The wire highline method of transfer uses a highline on which a trolley travels between ships.

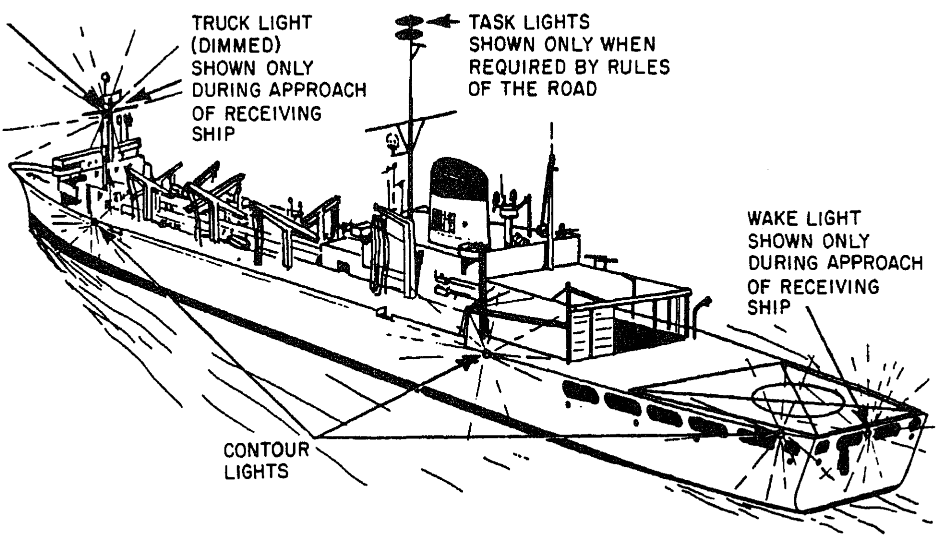


Figure 6-8.—Approach and station-keeping lights.

The highline extends from a winch on the delivery ship through an elevated block to a pad eye on the receiving ship (figure 6-9).

To use a wire highline, the receiving ship must have an attachment point at least 17 feet above the landing area deck. The point must be tested for a static load of 32,000 or 50,000 pounds. There also must be sufficient deck space in the area to handle incoming supplies.

If the receiving ship has the proper winch available, a 3/4-inch wire outhaul may be used. In this case, 3500-pound loads can be handled. If no winch is available, a manila outhaul must be used, which limits loads to 800 pounds.

As the delivery ship slacks the inhaul line, the receiving ship pulls the load across with the outhaul line. When the load is over the landing area, the delivery ship slacks the highline and sets the load on deck. It then retrieves the trolley (and empty nets) by reversing the process.

NONWIRE HIGHLINES

Nonwire highlines are similar to wire highlines, except manila or double-braided spun polyester (Dacron) is substituted for wire. These highlines can be used in transferring provisions, ammunition, personnel, and light freight. Because the manila highline is capable of supporting up to only 600 pounds for a 5-inch highline or 300 pounds for a 3-inch, it is used primarily for transfer of personnel. Two persons may be transferred at once on a 5-inch highline (4-inch polyester), but only one at a time may be transferred on a 3-inch line.

Preparations for nonwire highline are essentially the same as for a wire highline. No boom is necessary on the delivery ship; a 12-inch snatch block (14-inch block for a 5-inch highline) attached to a pad eye at the delivering station is sufficient. The highline is rove through this block and any other blocks needed to provide a fairlead. It is tensioned during transfers either by 25 to

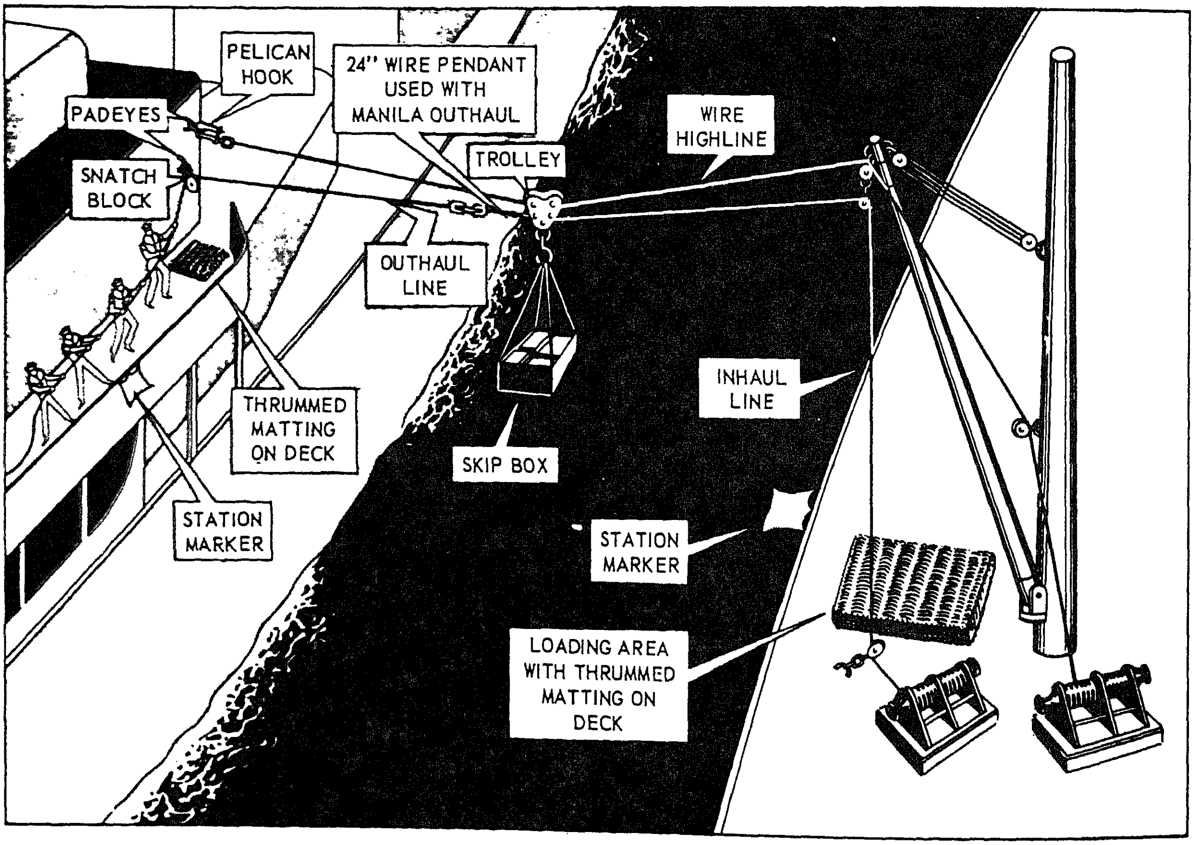


Figure 6-9.—Wire highline rig with manila outhaul.

50 personnel or by a capstan. The highline used for personnel transfer is tensioned by a minimum of 25 personnel. A highline that has been tended on a capstan may not be used for personnel transfer.

Normally, personnel are transferred in a transfer chair as shown in figure 6-10. Persons unable to sit up may be transferred in an especially equipped Stokes litter. A protective frame is secured above the litter to keep the trolley block from falling onto the passenger in case the highline should break. Flotation bags are lashed to the litter and protective frame to keep them and the passenger afloat if they fall into the water. The floats are canvas bags filled with kapok or fiberglass and painted with three coats of international orange plastic paint.

During personnel transfer, safety is the primary consideration, and the following precautions must be taken:

1. Highlines that have been tended from a gypsy head or capstan must not be used for personnel transfer.
2. Personnel being transferred in the chair must wear orange-colored, inherently buoyant lifejackets.
3. They must be instructed on how to release the safety belt and get out of the chair if they fall into the water.
4. Where water temperatures are extremely low, persons being transferred should wear immersion suits.
5. Whenever practicable, a lifeguard ship or helicopter should be stationed astern of ships making transfers. When a lifeguard ship or helicopter is unavailable, each ship must have a lifeboat and crew ready in all respects for rescue operations.

At night or during heavy weather, personnel transfer should not be attempted except in an emergency. In such instances, the following additional precautions must be taken.

1. To facilitate handling the chair and trolley, attatch a manila steadying line to each.
2. The lifejacket worn by the person being transferred must have a lighted white search light attached.
3. All cargo and fueling rigs must be disconnected before transferring personnel. A station-to-station telephone may be used forward of the transfer station, however, if it is carefully tended, so that it can be cut if necessary.

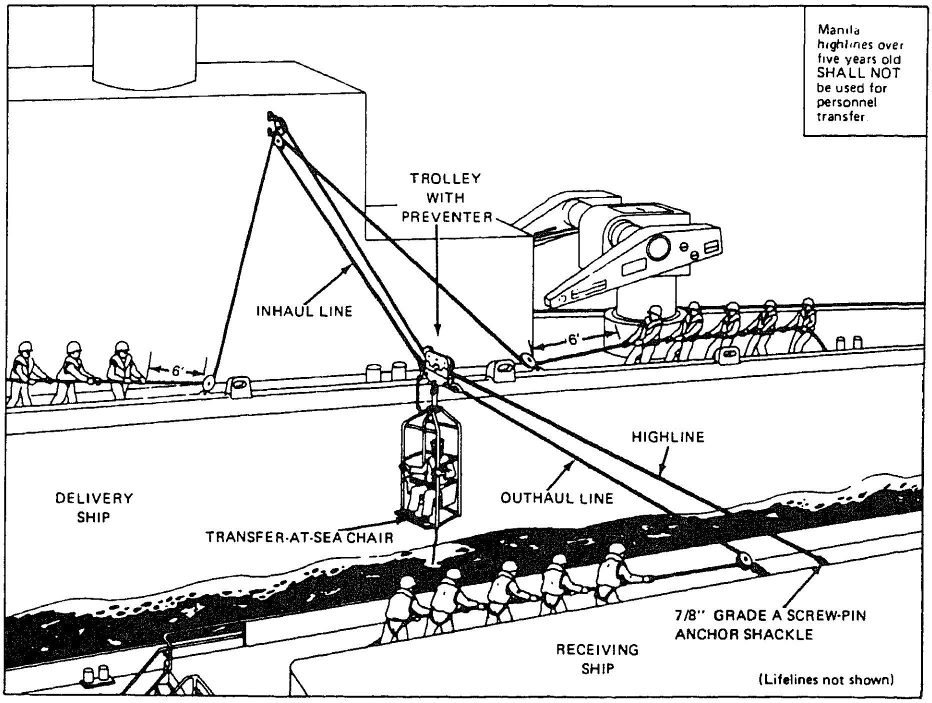


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Figure 6-10.—Personnel transfer by manila highline.

MISSILE/CARGO STREAM

STREAM is an acronym for standard tensioned replenishment alongside method. Cargo is transferred by a trolley riding on a constant-tensioned wire highline. The highline tension is not affected by the ship's motion and can be held for ship separation up to the amount of wire available.

Several STREAM rigs can be used, depending on the product being transferred, attachment points available, and equipment available in both the delivery ship and the receiving ship. Most of the STREAM equipment is installed in the delivery ship. Different rigging arrangements are used for the inhaul and outhaul, and different methods are used for lowering the load to the receiving ship's deck. Load capacities vary, depending on receiving ship pad eye static test load, sea state, and ship separation.

Figure 6-11 shows a basic STREAM rig consisting of three winches, ram tensioner, highline, outhaul, inhaul, and trolley. The trolley block is moved between ships by varying tension on the inhaul and outhaul lines, which are on separate winches. The ram tensioner works with the highline winch to maintain a constant tension in the highline by taking in or paying out wire. Ship's roll and minor changes in ship separation are compensated for automatically by the ram tensioner. Large variations require adjustment by the highline winch operator. The transfer head slides up and down on a track inside the king post (or M-frame) and contains the sheaves system for the highline and the inhaul wire. The outhaul block usually is mounted on the king post.

Two means of fairleading the outhaul are a standard UNREP receiving fixture (SURF) and a Concord block. These are sent by the delivery ship to the receiving ship. The SURF, which is used by destroyers and other ships not having a burton winch, is used in several types of rigs that are discussed later. The Concord block is used by ships having the capability to handle a burton whip, which is required because the rig is too heavy to be hauled in manually.

RECEIVING SHIP STREAM STATIONS

Attachment points on a receiving ship include sliding pad eyes and fixed pad eyes. Hardware requirements are similar to those for other cargo transfer methods.

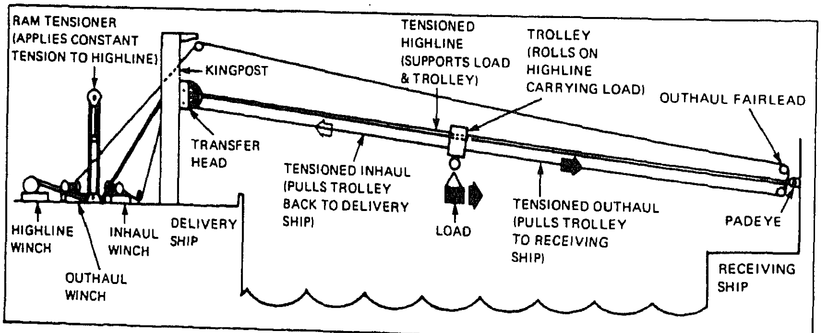
Sliding Pad Eye Receiving Station

The sliding pad eye is powered to move up and down in a guide track, which may be permanently mounted on a king post or a bulkhead. Portable types are stowed in trunks or in the overhead and moved, raised, or lowered to the operating position when needed.

The pad eye is lowered to a point near the deck for rigging. When operating the rig, the pad eye is raised to the top of the trackway when receiving loads and then moved down to lower the load to the deck. This feature provides good load control. When the sliding pad eye is used, the cargo drop reel is not needed. Loads up to the full capacity of the rig can be sent to or returned from the sliding pad eye station. A receiving station sliding pad eye rigged with a traveling surf is shown in figure 6-12.

Fixed Pad Eye Receiving Station

Although the fixed pad eye arrangement varies from ship to ship, STREAM rigs require one pad eye with a long link for connecting the 1-3/8 inch pelican hook on the highline. A second pad eye is required for a fairlead block for the rigging messenger or outhaul (depending on the



STREAM rig used). Fixed pad eyes are permanently mounted on the bulkhead, king post, or outrigger above the load landing area.

When using a receiving ship outhaul (hand-tended or winch-tended), the fairlead pad eye should be 6 to 18 inches below the highline pad eye to give direct pull on the trolley.

Use of a fixed pad eye keeps the highline at a single point above the load landing area. To lower the load, a cargo drop reel is used. Although less desirable, tension/detension may be used to lower the load; that is, the delivery ship slackens the highline to set the load on deck.

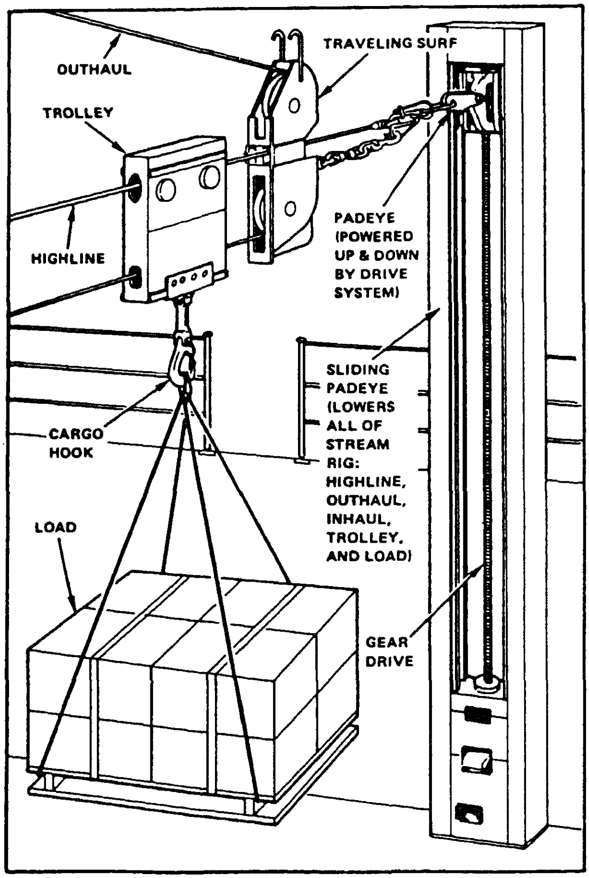


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Figure 6-12.—Sliding padeye.

CARGO DROP REEL

The cargo drop reel (CDR) is a device that lowers the load from the tensioned highline, thus permitting the use of STREAM rigs by ships having fixed receiving points. Although the CDR does not provide the same degree of control as a sliding pad eye, it does allow the load to be lowered under control of the receiving ship.

Two models are presently in use—the Mk I with a load capacity of 4000 pounds and the Mk II with a 5700-pound capacity (figure 6-13). The CDR's lifting capacity is limited to 150 pounds; empty pallets, therefore, should be returned to the delivery ship about every fourth load.

A load heavier than 150 pounds can be returned by the following method:

1. On the delivery ship, the transfer head is lowered to its full down position.
2. On the receiving ship, the load is secured to the CDR hook, all slack taken out of the CDR cable, and the brake set.
3. The delivery ship raises the transfer head to the top of the king post, which should allow the load to clear the deck of the receiving ship.
4. Upon reaching the delivery ship, the load is slowly lowered to the deck and disconnected.

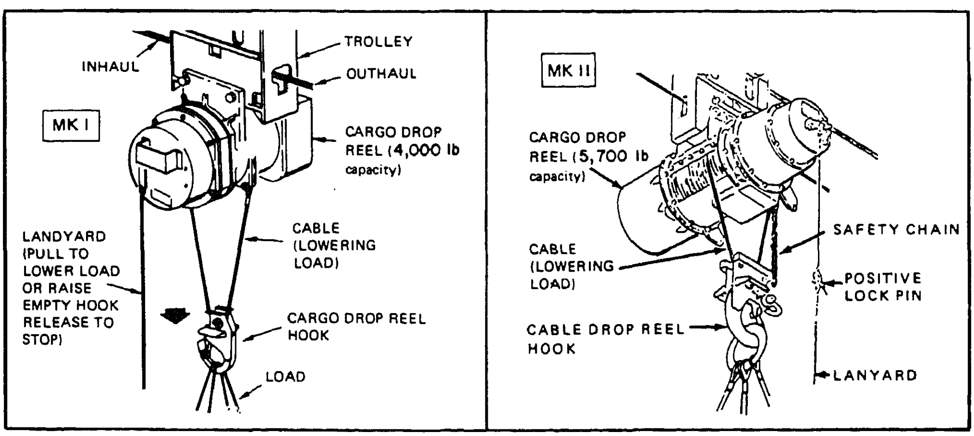

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Figure 6-13.—Cargo drop reel.

The CDR hook then is fully retracted and the transfer head lowered to permit hookup to another load.

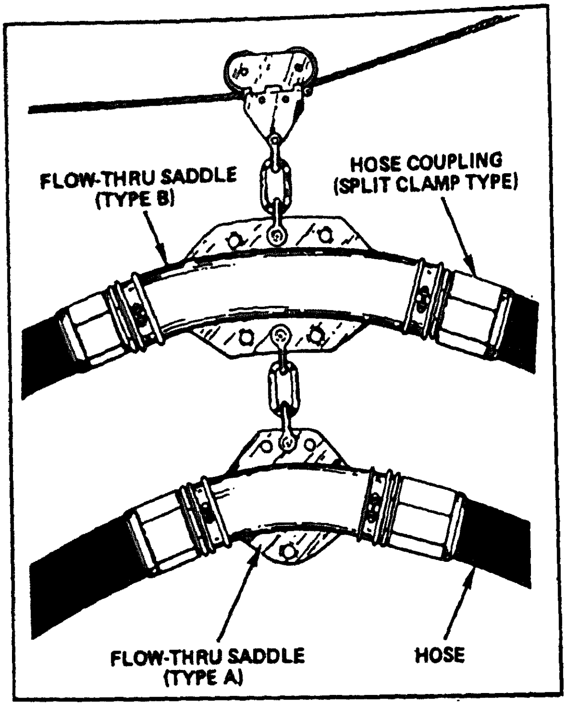

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Figure 6-14.—Hose saddles.

FUELING RIGS

Fueling at sea normally is conducted by using a span wire to support the fuel hose rig between the two ships. The span wire may be either tensioned or untensioned. An alternate method, the close-in rig, is used occasionally when the delivery ship is not equipped with the span wire or when the receiving ship cannot receive the wire due; for example, because of the lack of a pad eye that will stand the strain. Another method that may be used when fueling ships smaller than destroyers and when operating with NATO ships is the astern rig.

COMMON FEATURES

Like replenishment in general, a few features are common to two or more refueling rigs; notably hose, hose saddles, terminal fittings, and riding lines.

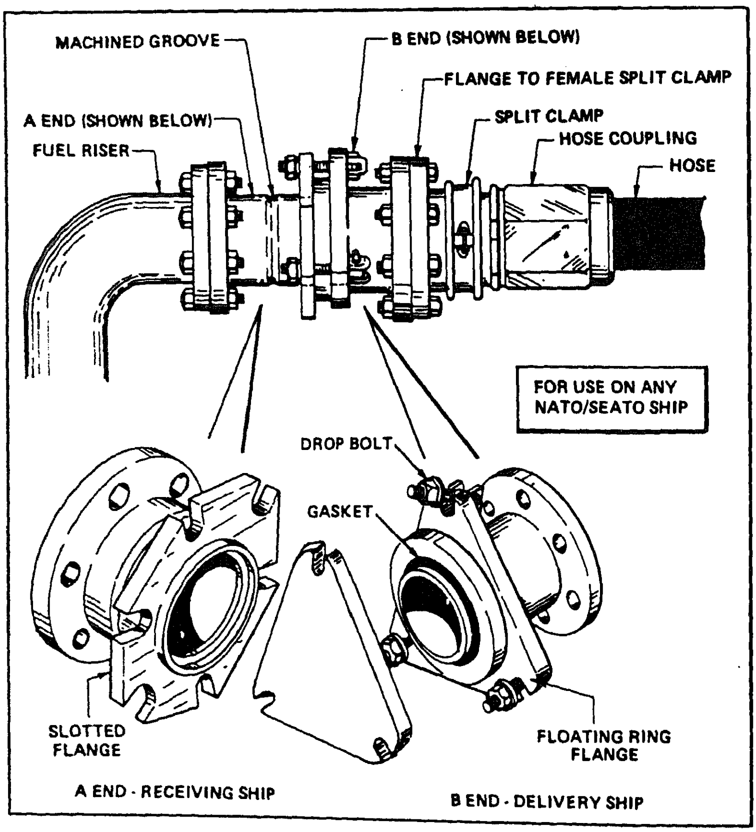

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Figure 6-15.—Breakable-spool, quick-release coupling.

The Navy uses a collapsible, lightweight hose that comes in 35-foot sections to 2 1/2-, 4-, 6-, or 7-inch diameters. The hose-end couplings are of a split-clamp type that permit joining sections to flow-through riding line fittings, to terminal fittings, and to flow-through hose saddles (figure 6-14). The saddles are used to support bights of hose from the various rigs. Two types of saddles are used: Type A (19 inches long) is found in single-hose rigs and in the lower hose in double-hose rigs; type B (32 inches long) is found in the upper hose in double-hose rigs.

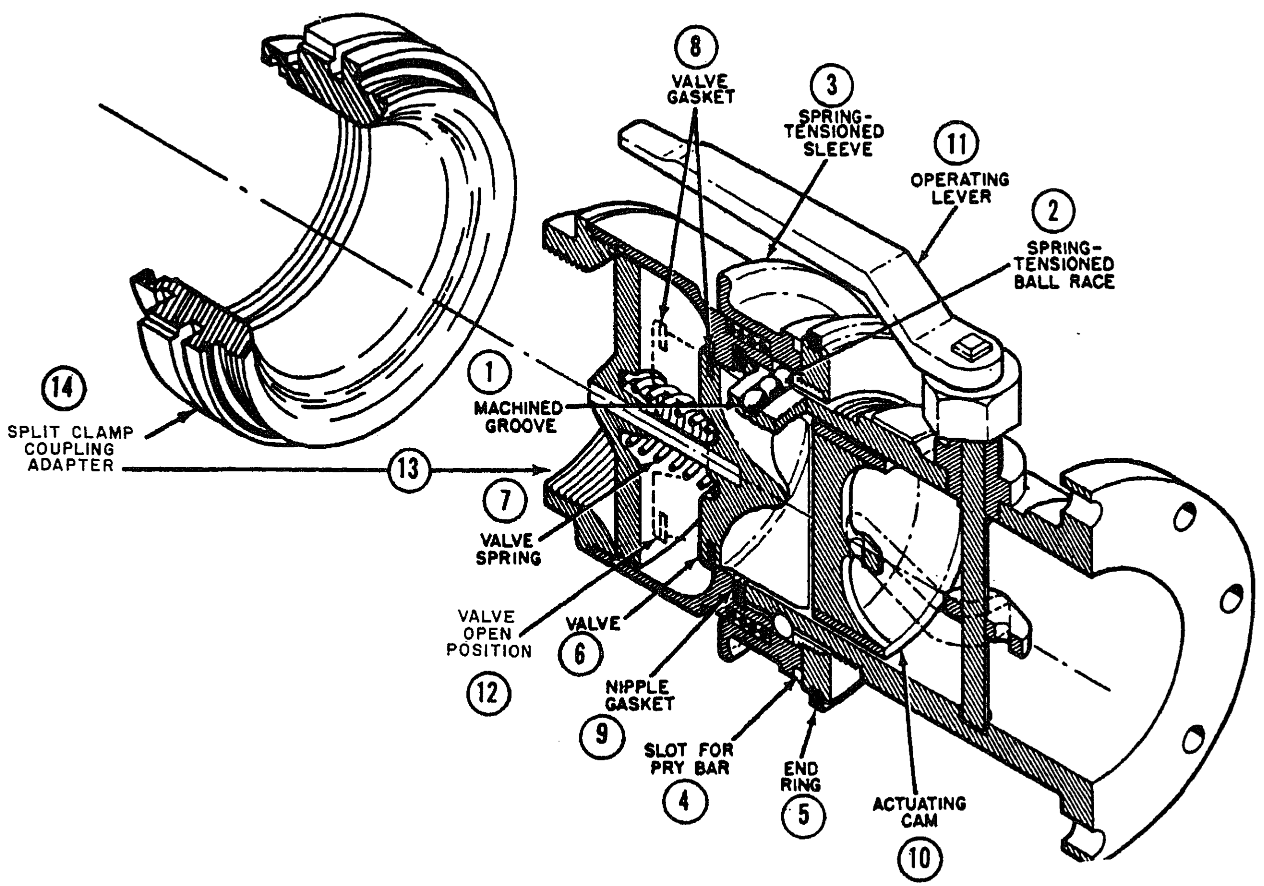
Terminal Fittings

Three types of terminal fittings, all designed for quick release, are used. They are the breakable-spool quick-release coupling (NATO), the combined quick-release (Robb) coupling and valve, and the fueling probe.

BREAKABLE-SPOOL QUICK-RELEASE COUPLING.—The breakable-spool quick-release coupling (figure 6-15) is used in fueling operations with NATO, SEATO, and MSC ships that are not equipped with a probe receiver. It is also used with the Robb coupling. It consists of an A-end and a B-end. The A-end, rigged on the receiving ship, is a cast-iron spool with a standard hose flange on one end and a slotted flange on the other. It is weakened by a groove machined around the spool. This groove is easily broken in an emergency by a blow from a sledge hammer.

The B-end is a similar spool with a standard hose flange on one end and a special floating-ring flange with drop bolts on the other. The floating-ring flange can be rotated to quickly bring the drop bolts in line with the slots in the A-end. A gasket mounted in the outboard end of the B-end ensures an oil-tight fit. A blank flange is attached to the B-end when the hose is being passed to prevent oil from spilling and water from entering the hose.

COMBINED QUICK-RELEASED COUPLING AND VALVE.—The combined quick-release Robb) coupling and valve (figure 6-16)



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consists of a female and a male end. The male end, rigged on the receiving ship, is a slightly tapered tube with a flange at one end. Near the other end is a machined groove (1). A spring-tensioned ball race (2) in the female end lines up with the groove, and a spring-tensioned sleeve (3) on the outside forces the balls down into the groove, holding the two ends together. When the sleeve is forced back by hand or, as usually is necessary, by pry bars, tension on the ball race is released and the male end can be withdrawn. Slots (4) are cut into the sleeve to permit the insertion of pry bars between the sleeve and the end ring (5).

A valve located in the female end (6) is normally closed and held in place by a heavy spring (7). A gasket (8) ensures a tight seal. Another gasket (9) provides a tight joint when the two ends are joined. A ring-shaped actuating cam (10) in the male end is linked to an operating lever (11). When the lever is turned to OPEN position, the cam is thrust forward, opening the valve (12).

Both 6-inch and 7-inch adapters (13 and 14) are available for the female end. Therefore, the coupling can be used with either size of hose.

Despite the name, the Robb coupling does not qualify as a quick-release device because uncoupling is virtually impossible when the fitting is under strain. For this reason, any strain must be taken by the riding line. The ends must be lined up perfectly to connect or disconnect. To provide for emergency breakaway, insert a breakable spool between the receiving ship's manifold and the male end.

Only United States ships are outfitted with the Robb coupling.

PROBE AND RECEIVER.—The probe fueling method was inspired by the method used to refuel aircraft in flight. The probe itself was modeled after that used by the aircraft. Preferably, the probe (figure 6-17) is supported by a tensioned span wire by means of a hinged trolley block assembly that can be attached to the span wire without disassembling the trolley. The probe contains a spring-tensioned latching mechanism that holds the probe in the receiver. A sliding sleeve valve opens when the probe seats properly and closes automatically when disengaged.

The receiver hangs from a swivel arm that pivots in a swivel joint. The span wire also hooks to the swivel arm; thus, regardless of the relative position of the ships, the receiver is kept aligned with the probe. Visual indicators mounted on either side of the receiver show when the probe is seated. As the probe mates, the indicators rise to the vertical, then drop back to a position approximately 30 degrees above the horizontal. When the probe is engaged properly, the latch mechanism prevents its being withdrawn under normal circumstances until it is disengaged. The usual way to disengage the probe is to pull on a manual release lever mounted on the receiver; however, a pull of about 2500 pounds on the inhaul also will disengage it.

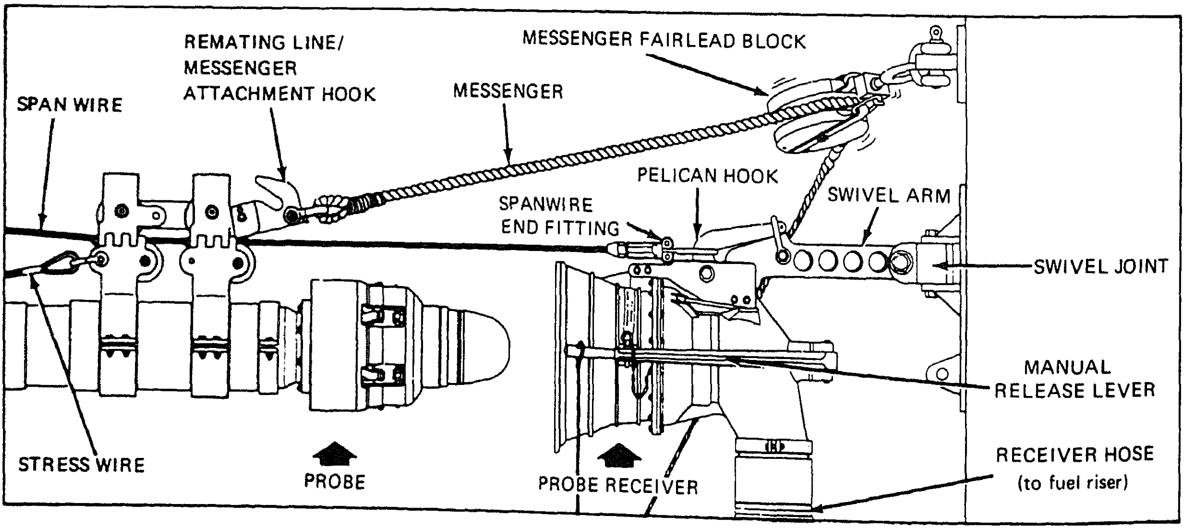

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Figure 6-17.—Single probe and receiver.

A remating line, furnished by the receiving ship, is dropped over the hook on the trolley block and provides means for manually engaging the probe or reengaging it should it be disengaged for any reason. A hose messenger is used to haul the probe to the receiving ship. This messenger can also be used to mate the probe and receiver.

SPAN-WIRE METHOD

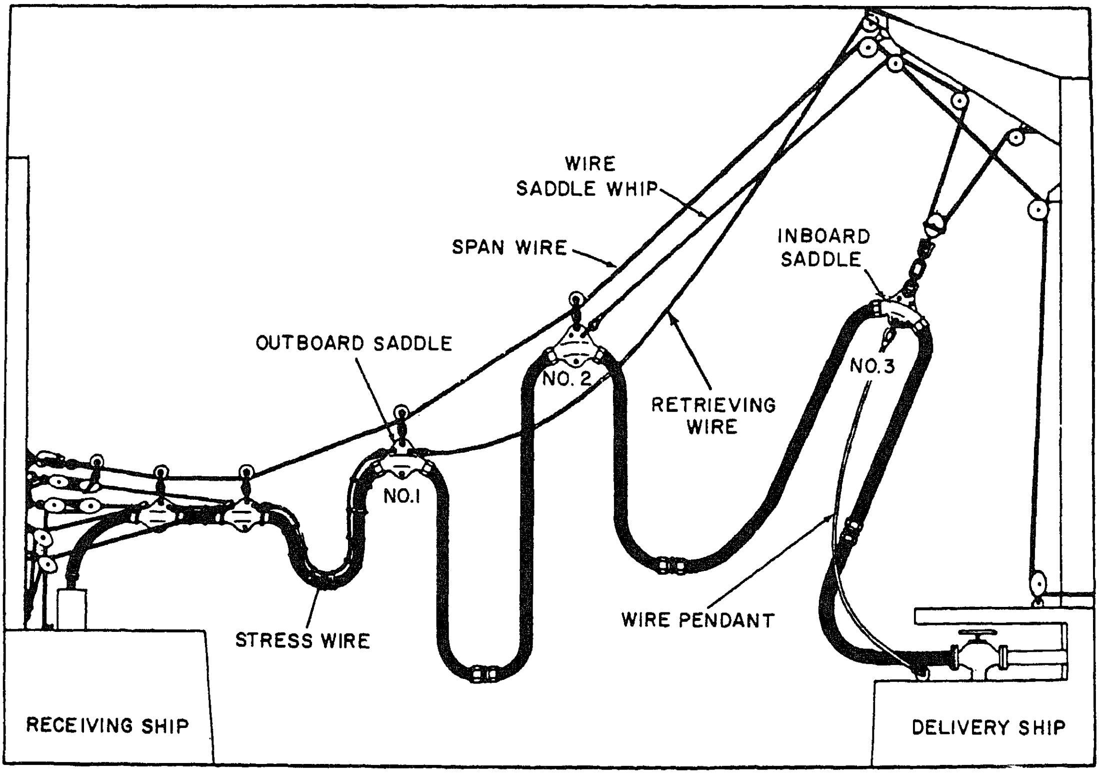
In the span-wire method of fueling at sea, the hose is carried between ships on a span wire, which may be tensioned (STREAM) or untensioned. The latter normally is referred to as the conventional span-wire rig. The hose hangs from trolley blocks that ride along the span wire. Saddle whips position the hose while fueling and serve to retrieve the hose after the fueling operation is completed.

The span-wire rig permits ships to open out to 140 to 180 feet. Such distance is reasonably safe and makes it fairly easy to maneuver and keep station. These factors not only allow commanders a wider latitude in choosing a fueling course, but they also facilitate the use of antiaircraft batteries should the need for them arise. Additionally, the high suspension of the hose affords fair protection for it in rough weather.

Ordinarily, in the span-wire method, saddle whips and the retrieving line are of wire; but when the necessary winch drums are not available and winches with gypsy heads are available, 3-1/2 inch, double-braided nylon line may be substituted for one or more of the whips. A wire rope retrieving whip is mandatory in double-probe rigs.

Figure 6-18 illustrates a typical span-wire rig. Starting at the inboard (oiler) end, the hose rig consists of the following components: two 35-foot lengths of hose, the inboard (no. 3) saddle, two 35-foot lengths of hose, the center (no. 2) saddle, two 35-foot lengths of hose, the outboard (no. 1) saddle, a 22-foot length of hose, a riding line fitting, a 4-foot length of hose, another riding line fitting, and a 9-foot length of hose.

Saddle whips are fairlead from their winches through blocks at the boom head (or outrigger) to their respective saddles. The outboard whip is the retrieving wire. The inboard whip controls both the inboard and center saddles. A wire pendant secured between the deck and the inboard



saddle prevents the saddle from being two-blocked. Should the saddle be two-blocked, it can jam, allowing the whip to reeve freely through the blocks, permitting the number 2 saddle to slide down the span wire and, consequently, putting a strain on the hose.

The hose is suspended from the span wire by trolleys at the center and outboard saddles and the two riding line fittings. Two free trolleys support the outer end of the hose and are cut loose as the hose comes aboard. Riding lines secure the hose in place.

Upon completion of fueling, the receiving ship disconnects the hose coupling and eases the hose outboard by slacking the riding lines, while the oiler heaves in on the saddle whips. When the hose has been retrieved, the delivery ship slacks the span wire, the receiving ship trips the span wire pelican hook and eases the wire over the side with an easing-out line, and the oiler recovers the rig.

PROBE METHOD

As shown in figure 6-17, the probe system consists of a male probe on the outboard end of

Table 6-1.—Distance Between Ships for Various Rigs

Ship Type	Type of Replenishment Rig				
	Missile/cargo STREAM*	Burton, housefall, modified housefall, wire highline, manila highline	Fuel STREAM**	Nontensioned span wire fueling rig	Close-in fueling rig
DD types and smaller	80′ – 200′ normal 300′ max	60′ – 100′ normal 180′ max	60′ – 180′ normal 200′ max	60′ – 100′ normal 180′ max	60′ – 80′
Larger ships	80′ – 200′ normal 300′ max	80′ – 120′ normal 200′ max	80′ – 180′ normal 200′ max	80′ – 120′ normal 200′ max	
Carriers	100′ – 200′ normal 300′ max	100′ – 140′ normal 200′ max	80′ – 180′ normal 200′ max	100′ – 140′ normal 200′ max	

*Minimum separation of 100 feet required during tension/detension transfer method.
**300-foot heavy weather rig.

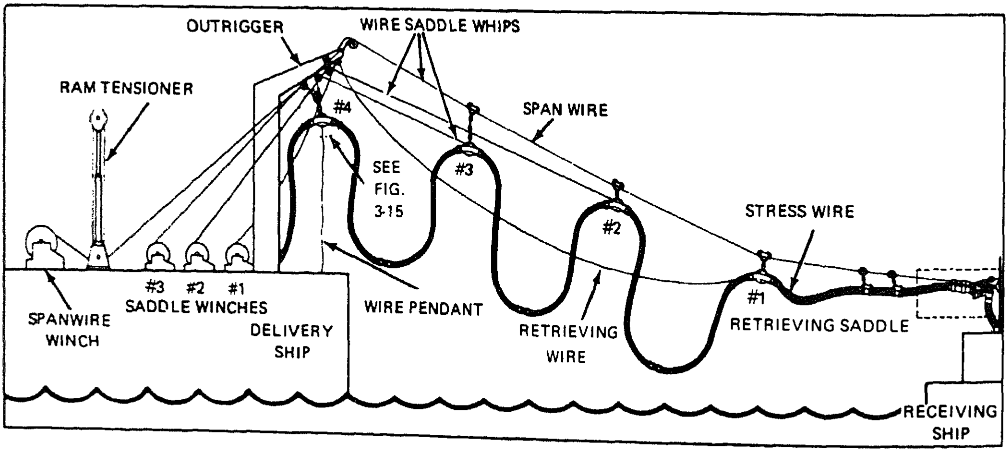


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Figure 6-19.—Fuel STREAM, single hose with probe.

the oiler's 7-inch hose and a receiver mounted on a swivel arm on the receiving ship. A pelican hook secures the span wire, which may be tensioned or nontensioned to the swivel fitting. This arrangement ensures proper alignment for mating the probe and receiver.

The STREAM fueling rig is similar to the span wire rig except that the hose may be longer, necessitating an additional saddle. No riding lines are used, and the span wire is ram-tensioned (figure 6-19).

If ship separation is less than 140 feet, the angle of the span wire is such that the delivery ship can ease the hose down to the other ship. Normally, however, the receiving ship hauls the hose aboard by means of the messenger. After the probe is engaged in the receiver, the remating line is attached to the probe by the receiving ship, and the hose messenger is disconnected and returned to the delivery ship. A pull of approximately 300 pounds is required to engage the probe.

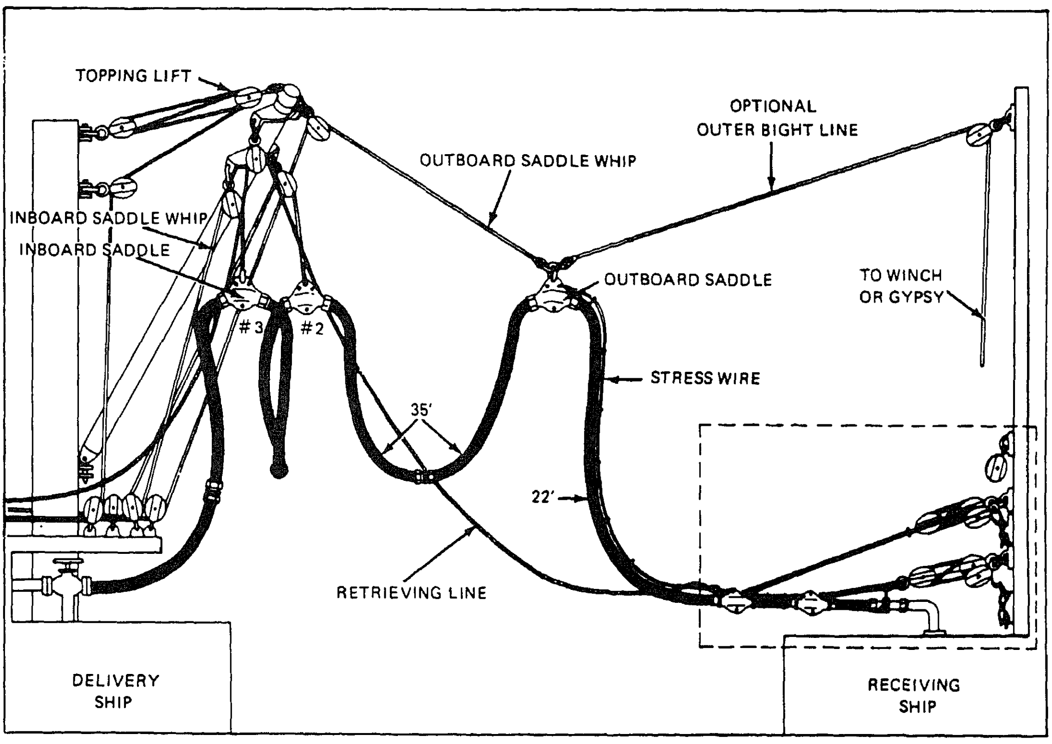
After fueling is completed, the remating line is unhooked and the manual release lever on the probe receiver is used to free the probe. When the oiler has hauled in the hose, it slacks the span wire, which the receiving ship disconnects and eases over the side with an easing-out line.

CLOSE-IN METHOD

In the close-in rig (figure 6-20), the hose is supported by whips leading from the hose saddles to booms, king posts, or other high projections on the delivery ship. When the rig is used to fuel ships larger than destroyers, the outboard bight of hose also may be supported by an outer bight line leading from the outboard saddle to a high point on the receiving ship. The outer bight line is passed to the receiving ship by means of the hose messenger.

PROCEDURES

The need for working at close quarters makes maneuvering during replenishment a critical operation. The distance between ships depends mainly on the type of ship being serviced and the type of rigs employed. A destroyer using a regular span-wire fueling rig, for instance, maintains a normal separation from the replenishing ship of between 60 and 100 feet; a carrier with the same equipment maintains a distance of between 100 and 140 feet. Table 6-1 lists optimum distances between ships for various types of replenishment rigs.



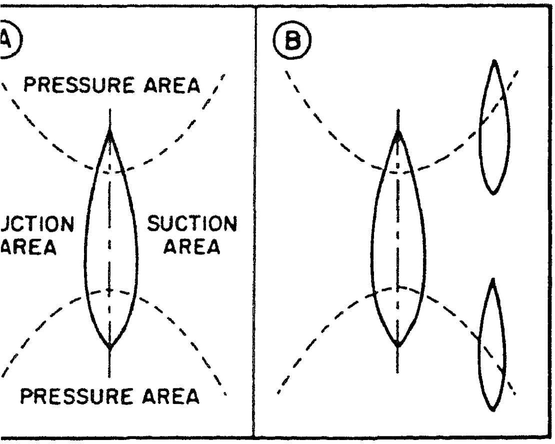


Figure 6-21.—Venturi effect.

Other considerations that bear on the best tance are sea conditions, alongside maneuver- ility, water depth, and speed. When ships yawing badly, the distance should be near maximum allowable. When water depth ess than 35 fathoms, the distance should be reased as the water becomes more shallow. stance should also be increased as speed reases.

Pressure effects must also be taken into count. A ship underway creates a venturi ect, with areas of high pressure at the bow and rn and decreased pressure (suction) amidships gure 6-21). When ships are alongside each other, effect is increased and becomes further nplicated because of the intermingling of ssure areas. The effects vary with the size and nfiguration of the ships, the distance between ps, and speed.

When ships of the same size are alongside, the t position is exactly abeam. If the approach p is considerably smaller than the control ship, area between the bow and stern pressure area best.

Figure 6-21 shows ships that are in dangerous sitions because they are being acted on by lically different pressures. Changes in relative sitions will impose rapid changes in the pressure ects on their hulls. Either ship position may uire quick rudder action by the smaller ship. e hazard is increased if speed is reduced. dical speed changes will further aggravate the uation.

Replenishment operations usually are conducted in relatively deep water. In shallow water, pressure effects are more pronounced and extra care is required in maneuvering.

RESPONSIBILITIES

UNREP responsibilities are set forth in terms of shiphandling and the rigs used. Shiphandling responsibilities are those of the control ship and the approach ship, while those for the rigs are related to the delivery ship and the receiving ship. The terms are independent, but normally the control ship is the delivery ship, with the approach ship being the receiving ship. Exceptions will be noted.

The control ship is the guide and, as such, maintains a steady course and speed. Wind and sea conditions permitting, the best course is into the sea at a speed between 12 and 16 knots. Speeds less than 8 knots are inadvisable because of reduced rudder effect. Speeds in excess of 16 knots require greater lateral separation because of increased venturi effect.

Course and speed changes during UNREP are undesirable but can be accomplished safely through close coordination between the delivery and receiving ships. Course changes should be made in 5 degrees steps (10 degrees in emergencies) with enough time lapse between steps to permit steadying up. Rudder angle used is that which will produce a tactical diameter of 3000 yards.

The delivery ship announces when its rudder is put over, when passing each degree of heading, and when steadying up.

Speed changes may be made in 1-knot increments, steadying up on each intermediate speed. They should not be made simultaneously with course changes.

THE APPROACH

When the delivery ship is steady on replenishment course and speed, it indicates that preparations are being made to receive a ship alongside by flying ROMEO at the dip on the side being rigged. (See figure 6-22.) It hoists ROMEO close up when ready to receive the other ship.

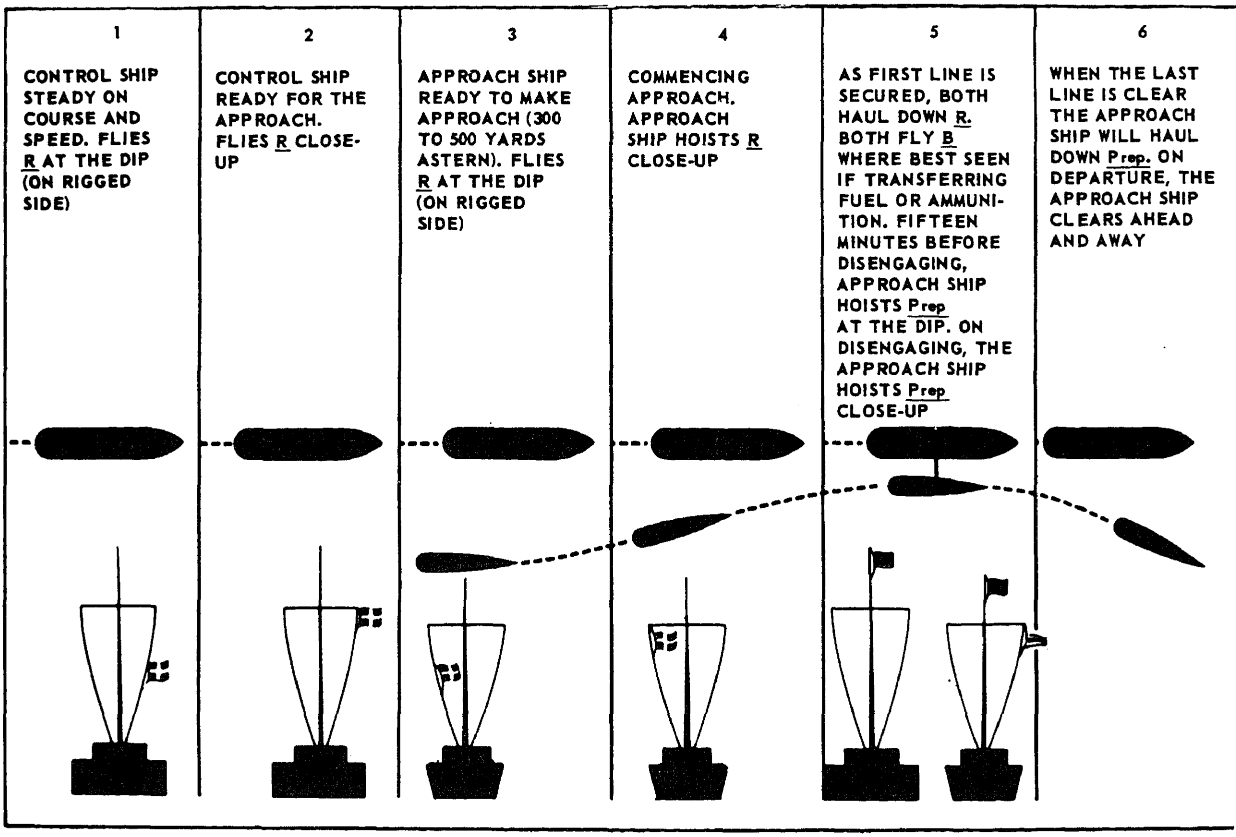


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Figure 6-22.—Approach, riding alongside, and departure.

When the receiving ship is ready to make its approach, it hoists ROMEO at the dip on the rigged side. It should be 300 to 500 yards astern of the delivery ship, on replenishment course and speed, and should have completed preparations to be replenished. When the receiving ship starts its approach, ROMEO is hoisted close up. At this time both ships hoist the day shapes required by the Navigational Rules of the Road for ships restricted in their ability to maneuver—two black balls in a vertical line with a black diamond between them. The nighttime signal is three all-round lights in a vertical line, with the upper and lower lights red and the middle light white. These signals are displayed until the receiving ship clears the delivery ship.

Because of water pressure differentials, adequate lateral separation during the approach is essential to prevent the bow of the approach ship from veering into the quarter of the delivery ship.

Approach speed should be 3 to 5 knots great than that of the control ship. When the receivir ship is in position alongside the delivery ship, tl lines are passed. As the first line across is secure both ships haul down ROMEO. Each ship fli BRAVO where best seen if transferring fue explosives, or flammable products.

Normally, the delivery ship furnishes a rigs—bolo/gun lines, station-to-station phoı line, and a messenger for the bridge-to-brid phone/distance line. Exceptions are th CVs/LHAs/LPHs and other ships carryir aircraft as deck cargo furnish the bolo/gun lin When using any burton rigs, the receiving sh furnishes the burton whip messenger and statio to-station phone line.

A typical rig-passing procedure is as follow

1. On the delivery ship, a B/B phone/distan line messenger, a STA/STA phone line, and span-wire messenger retrieving line are attach

he main (span/wire) messenger (figure 6-23). e messenger retrieving line may be shackled he hose messenger/remating line attachment k.)

2. Before firing or heaving the lines, the word assed on both ships over the 1MC and/or by tric megaphone (bullhorn) as follows:

FIRING SHIP: "on the (name of receiving), stand by for shot lines. All hands topside cover."

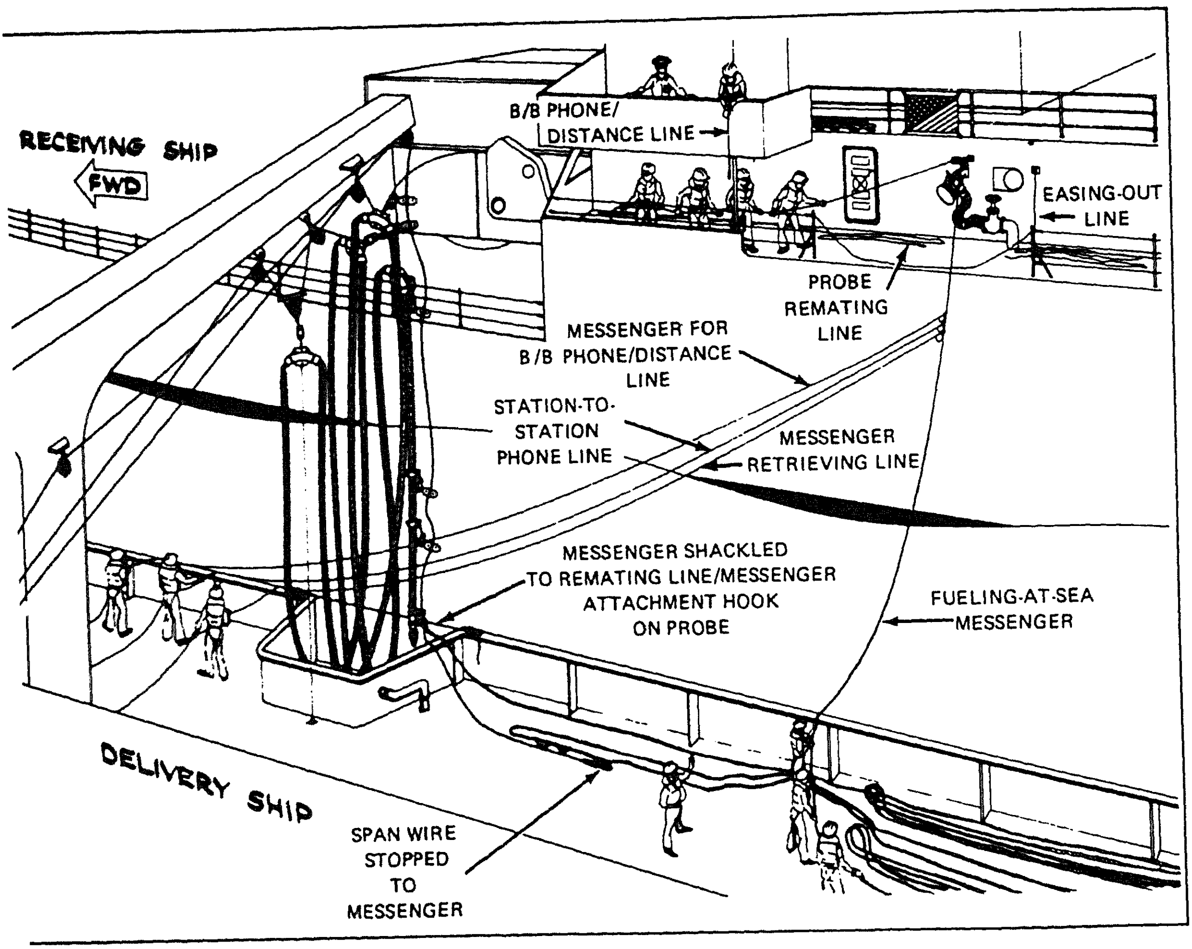
RECEIVING SHIP: "On the (name of own), stand by for shot lines at (stations cerned). All hands topside take cover."

3. When ready to pass the bolo/gun line, each on on the delivery ship sounds one blast on lice whistle. When ready to receive the shot each station on the receiving ship replies with two blasts on a police whistle. The delivery ship then fires the shot lines.

4. The main messenger is passed to the receiving ship which hauls in the lines, connects the STA/STA phone line, and attaches the zero end of the B/B phone/distance line to its messenger. The span wire is then hauled over and connected as previously described. (CVs and other ships carrying aircraft send over their distance and phone lines and a messenger for hauling in the span wire.)

5. The delivery ship hauls in the B/B phone/distance line and secures the zero end to an outermost rail.

6. A STA/STA phone line is passed from the delivery ship to the receiving ship at each transfer station in use.



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MAINTAINING STATION

While alongside, maintaining station on the part of the receiving ship requires precise adjustments. Steaming too close restricts maneuverability and increases risk of collision; too great a separation puts an undue strain on the rigs.

A small amount of rudder usually is necessary to maintain station alongside. The amount of rudder required varies with such factors as the size and load of both ships, sea and wind conditions, speed, lateral separation, and location and type of rigs used.

When STREAM is used, the receiving ship conning officer (especially if on a destroyer or other small ship) must be alert to avoid being drawn in toward the delivery ship. Once all rigs are tensioned, it often is necessary for the receiving ship to steer a slightly different heading to maintain the prescribed course and separation.

Shiphandling is most difficult when using the tension/detension method. The sudden and repeated strain and relaxation require prompt and frequent rudder changes on the receiving ship. A delivery ship replenishing to both sides must be prepared for rudder changes when one side detensions while the other side is tensioned. The receiving ship must also be alert to this situation.

When a large ship comes alongside a delivery ship, the latter must be prepared for a speed reduction of as much as 1 knot; if a ship is along the other side, its conning officer must be alerted.

When the delivery ship changes course or speed during replenishment, the need for coordinated action requires personal communications between the conning officers. The delivery ship advises the receiving ship when the following things occur:

1. When rudder is shifted for the change
2. As each degree of heading is passed during the turn
3. When rudder is shifted to steady

On the receiving ship, the conning officer must know the average amount of rudder carried to maintain station and the amount needed to start the turn. During the turn, the conning officer constantly observes the following:

1. The gyro heading
2. The rate of turn
3. Distance to other ship
4. Parallel relationship of ships
5. Fore and aft positions relative to delivery ship

Additionally, the conning officer must adjust the speed during the turn. If the ship is inside the turn, speed is reduced; if outboard, speed is increased.

The conning officer may give helm orders in one of two ways. The order may be given "Come right (left) to (the signaled course)" for changes of less than 5 degrees and on large ships with slow rudder response. Alternately, the conning officer may order continuous course changes in 1- or 2-degree steps during the turn ("Steer____"). The latter method is desirable for turns of 5 degrees or more and in ships with quick rudder response.

Speed changes initiated by the delivery ship normally are in 1/2- or 1-knot increments.

BREAKAWAY (NORMAL)

Fifteen minutes before the conning officer on the receiving ship expects to complete replenishment, PREP is hoisted at the dip to notify the next ship scheduled to replenish.

On completion of the UNREP all nets, slings, lines, and hoses are returned to the delivery ship. Messengers are passed back last to facilitate the delivery ship's preparations for transferring supplies to the next ship.

On disengaging, the receiving ship hoists PREP close up. When the last line is clear, it is hauled down. When clearing the side, the conning officer increases speed moderately (3 to 5 knots) and clears ahead, directing the course outboard in small steps. Propeller wash caused by radical changes in speed and course can adversely affect steering of the control ship. A dangerous situation may develop if a ship is on the other side. Also, when a large ship departs, the conning officer of the control ship should be prepared for a slight increase in speed and, if another ship is alongside, to so inform its conning officer.

EMERGENCY BREAKAWAY

An emergency breakaway is an accelerated normal breakaway using an orderly, prearranged procedure. The receiving ship must disengage quickly, without damaging rigs or endangering personnel.

After station-to-station communications are ıblished, the officer-in-charge of each transfer ion on the delivery ship should contact the icer-in-charge on the receiving ship to review ergency breakaway procedures. The delivery ɔ sends over written instructions with the first s. When bridge-to-bridge communications are ıblished, the commanding officers may review actions to be taken.

In anticipation of an always-possible emer- cy, all lines brought aboard the receiving ship faked clear for running; and messengers are ayed to cleats clear of stores, ready for instant king. A sufficient number of personnel must tationed and ready to disengage quick-release plings, span wires, riding lines, and other lines h dispatch. Tools such as hammers, axes, ves, and bolt cutters should be on hand for ergency use.

The order for emergency breakaway may be en by the commanding officer of either ship. ficient time to allow the receiving ship to ngage the rigs is of paramount importance. ling rigs in particular are subject to severe nage if not properly released at the breakaway nal—damage that may require vital hours to air. The ship ordering the breakaway sounds danger signal on the ship's whistle to alert er ships in the area.

When the commanding officer orders ergency breakaway, signalmen at the transfer ions rotate a red paddle, flag, or wand in a icircular arc overhead to indicate "prepare for ergency breakaway." The ship alongside nowledges with the avast heaving signal and, en ready, responds with the emergency akaway signal. On the originating ship, almen then lower their paddles from the rhead position to initiate the breakaway.

PLENISHMENT FROM TANKERS

The United States military services regularly tankers to transport petroleum products from nt to point throughout the world. These kers, including both government-owned and ustry-owned ships, are operated by shipping npanies under a contract or a charter with the itary Sealift Command (MSC). These tankers e limited fueling-at-sea equipment ("limited" hat they can refuel only those fleet units which pass a spanwire rig installed for transferring oleum products at sea by the alongside hod). The U.S. Navy supports the installation such equipment to increase national defense abilities.

This fueling-at-sea capability contributes to fleet readiness and provides increased flexibility during emergencies. By supplying petroleum products to Navy ships at sea, tankers make it possible for fleet units to remain on station instead of having to break off operations and return to port for reloading.

ALONGSIDE REFUELING. For alongside refueling, tankers are equipped to use the spanwire method. Installed equipment includes:

1. Tripods and fittings mounted on the main deck to accommodate the rig sent over by the fleet unit. On some tankers, existing kingposts are used in lieu of tripods.
2. Quick closing valves at cargo manifolds.
3. Pipeline extensions to transfer stations.

Most tankers have four discharge stations, two on each side. The forward stations (port and starboard) are aft of the midship deck house. The after stations are forward of the after deck house. (A few tankers have six stations, three on each side.)

Tankers can transfer bulk petroleum products to fleet ships from two stations on one side and, on a few hours notice, can rig jumper hoses on deck to handle double hoses at each station on one side. In most cases, lack of manpower prevents tankers from transferring cargo from both sides at the same time. However, to expedite refueling, a tanker's merchant marine crew may be augmented by additional personnel prior to sailing. If additional personnel are not assigned, a tanker normally cannot connect or disconnect more than one hose at a time.

PERSONNEL DUTIES. A tanker crew varies from 24 to 32 men, depending on the ship's design and state of automation. The master must ensure that his crew is adequately trained and prepared prior to a refueling operation, and that all stations are manned with the most capable personnel.

Along with normal sea and discharging functions, other duties include: phone talkers, line handlers, visual communications, rigging/unrigging, and adequate officer supervision. The chief engineer should be located in machinery spaces and be prepared to answer bells promptly and handle any possible emergency.

COMMUNICATIONS AND RENDEZVOUS PROCEDURES

When assigned to a replenishment operation, the tanker may be directed to rendezvous with a

naval unit or the naval unit will rendezvous along the tanker's track. To expedite rendezvous and facilitate preparations necessary for an efficient transfer of cargo, establish communications between the tanker and fleet unit well in advance of the scheduled rendezvous.

Communication methods used by tankers for replenishment operations include radiotelegraph and radiotelephone, sound-powered phone, megaphone, flags, light signals, and walkie-talkies.

Radiotelegraph messages addressed to tankers must have plain language headings. Only international radio calls will be used. Tankers do not hold Navy call sign publications or call sign encryption devices, and they do not have cryptographic capability.

If radio silence is prescribed, tankers will not transmit by radio except in cases of distress.

When weather or operations require it, the naval commander may change the time and place of rendezvous by direct liaison with the tanker. He may also direct the tanker to enter port to accomplish or complete the operation.

REPLENISHMENT COURSE AND SPEED

When rendezvous has been effected, the naval commander designates the course and speed for the replenishment operation. The course and speed most favorable for the tanker are preferred because the tanker's refueling stations are on the main deck. The tanker should be on the lee side of the fleet unit. The fleet unit makes the approach and adjusts course and speed to maintain station on the tanker.

MAINTAINING STATION

THE TANKER MAINTAINS THE PRESCRIBED COURSE and keeps the fleet unit informed at all times of the course being steered. The helmsman must maintain heading within one or two degrees of the designated course.

EXPERIENCED HELMSMEN must be used during refueling operations. Normally, the three best helmsmen should be used to relieve each other every half hour except when it appears more advantageous to use a different arrangement because of the estimated refueling time or the availability of experienced helmsmen. An experienced helmsman will be assigned to monitor the actions of the helmsman.

STEERING CONTROL should be by hand, but the automatic gyropilot may be used if conditions are such that the master determines he can maintain safe and effective steering control. When the automatic gyropilot is used, an experienced helmsman must be on station, alert, and ready to shift to hand steering (either electric or hydraulic if necessary).

The tanker maintains the prescribed speed as agreed upon with the naval commander. Normally, a refueling speed of 12 to 14 knots will allow maximum tanker pumping rates with the fleet unit able to maneuver and maintain station effectively. Higher speeds may be obtained, depending on the capabilities of units involved.

The distance between ships that is best for safety and operational purposes varies with the wind and sea conditions, the maneuverability of the ship alongside, and the type of transfer rig.

Optimum separation is 100 feet for the normal spanwire rig. However, when using the fuel STREAM rig, separation should be 150 to 200 feet.

To maintain course when a ship is alongside, the other ship should continuously carry a small amount of rudder. The amount depends on the size of both ships and their loads, sea and wind conditions, speed, and the distance between ships. As cargo is transferred and the trim of the ships change, the amount of rudder required to maintain a steady course will change.

REPLENISHMENT PROCEDURES

Tankers are not equipped to pass fueling rigs to receiving ships. They are, therefore, limited to refueling fleet units which can pass the spanwire rig to the tankers. Information about the spanwire rig is provided in this chapter. To apply this information to refueling by tankers, substitute the word TANKER for receiving ship and the word OILER or words FLEET UNIT for delivery ship.

The fleet unit supplies the rig and passes all lines (including the phone/distance line) to the tanker. Because of the shortage of manpower on the tanker, only one rig should be passed at a time. The fleet unit tends all lines.

As the fleet unit comes alongside, a shot line is passed to the tanker by means of a line-throwing gun or bolo (a padded weight, heaved by hand). The shot line is attached to the 3 1/2-inch or 4-inch manila hose messenger by suitable lengths of 6-thread or 9-thread and 21-thread manila, taper-spliced together. The phone/distance line, station-to-station telephone line, and span wire are attached to the hose messenger.

ʼASSING THE RIG

1. The tanker hauls in on the shot line and he first messenger. The phone/distance line is ecured, with the zero mark at the tanker's rail ır on a stanchion directly below the navigation ıridge. Telephones are hooked up.

2. The tanker continues to haul in until the ıessenger comes aboard. This line is placed into he 12-inch snatch block below the spanwire adeye and then is led to a winch and hauled in ntil the spanwire pelican hook is aboard.

3. The pelican hook is secured to the padeye n the tripod or kingpost; the span wire is etached from the messenger, and the fleet unit ıkes up the slack in the span wire.

4. Tanker personnel resume heaving in on the ıessenger to bring the hose on board.

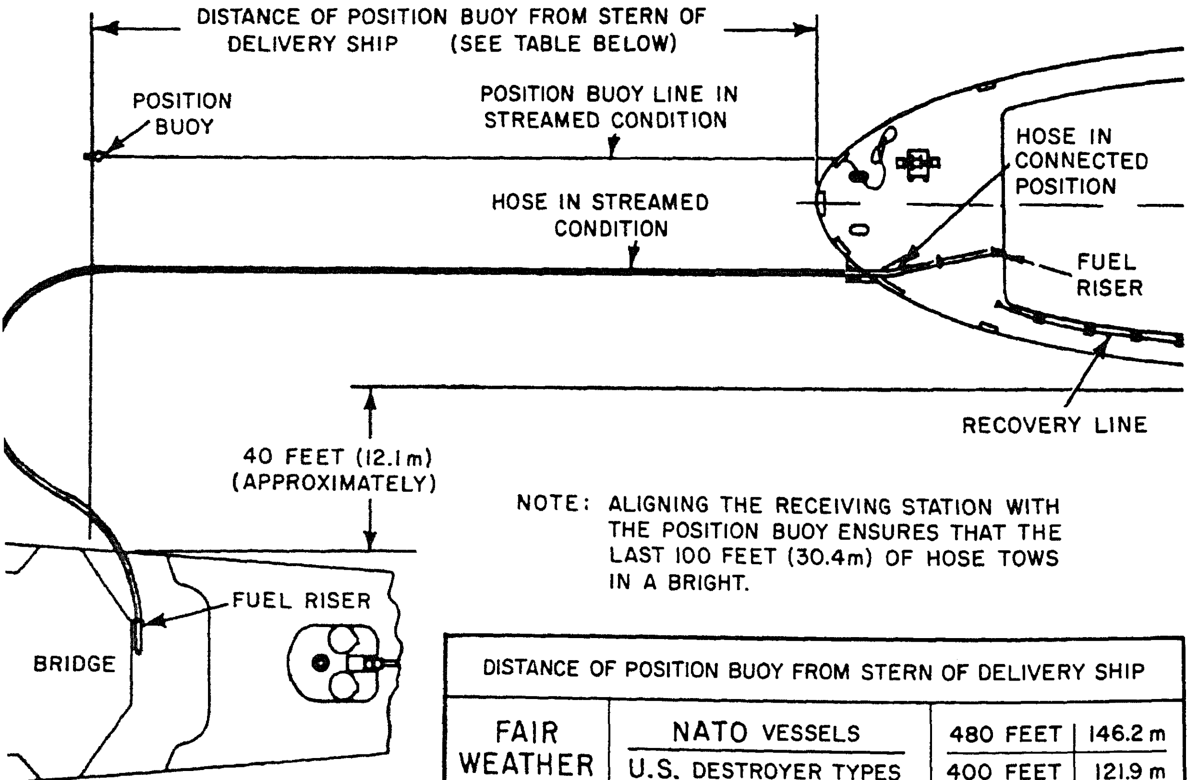
5. The stops securing the hose to the ıessenger are cut, and the hose is pulled in until a bight (not an eye) of one riding line can be slipped over the riding line hook. Two riding lines must be attached as soon as practicable and, in any case, before pumping commences.

6. The blank flange or cap on the hose is removed, and the hose is connected to the fitting on the tanker.

7. Using the messenger retrieving line, the messenger is immediately returned to the fleet unit.

EMERGENCY BREAKAWAY

Personnel must be assigned specific emergency breakaway duties in advance. Knives, marlinespikes, wrenches, axes, and sledge hammers must be on hand. At no time should refueling stations be left unattended.



DISTANCE OF POSITION BUOY FROM STERN OF DELIVERY SHIP			
FAIR WEATHER	NATO VESSELS	480 FEET	146.2 m
	U.S. DESTROYER TYPES	400 FEET	121.9 m
FOUL WEATHER	NATO VESSELS	690 FEET	210.3 m
	U.S. DESTROYER TYPES	610 FEET	185.9 m

284.36

Figure 6-24.—Typical astern fueling station keeping.

If an emergency breakaway is ordered, the following procedures are of major importance:

1. Stop pumping immediately.
2. Return phone/distance and station-to-station telephone lines. Ensure that all unnecessary persons are clear of the transfer station. The hose may whip around when released. Also, since a blowdown is not possible, oil spillage from the hose may create slippery footing.
3. If a breakable-spool coupling is used, break it by striking the groove a sharp blow with a sledge hammer. If a Robb coupling is used, force back the sleeve on the coupling with two marlinspikes until it releases. When both the breakable-spool and Robb coupling are used in combination, strike the groove of the breakable spool a sharp blow with a sledge hammer.
4. Ease out the hose with one riding line. If necessary cut both riding lines.
5. If possible, trip the pelican hook after the fleet unit has slacked the span wire. The person tripping the pelican hook must be inboard of the hook, especially if there is no opportunity to use an easing-out line on the span wire.

MERCHANT TANKER ASTERN FUELING OF ESCORT SHIPS. Six U.S. flag tankers are presently equipped with an astern fueling rig. By 1985, 18 MSC controlled ships are scheduled to have astern rigs in place. This capability is expected to provide a more readily available source of fuel for the mobile logistic support of escort ships. In addition, necessary lightweight hoses, fittings and equipment are stored ashore in mobilization reserves, available for installation on other tankers as required. Most tankers can be adapted for astern fueling in three days or less.

In the astern method of fueling, the merchant tanker streams a single 6-inch hose rig (through a stern roller assembly). The hose terminal fitting will be the NATO breakable spool coupling (figure 6-15). The escort ship maintains station astern and outboard of the delivery ship while receiving fuel at a forward fueling station. Figure 6-24 is a plain view drawing of a typical astern fueling operation. It illustrates the most desirable location of the receiving station relative to the marker buoy.

COMMUNICATIONS. Basic communications and rendezvous procedures will be conducted as outlined previously (sound-powered telephone lines will not be passed). The flag hoist signals (figure 6-22) will be used during astern fueling operations in addition to the control signals designated in Table 6-2. The signals will be displayed at the appropriate fueling station in both ships. The station flags indicated shall consist of 3-foot squares of bunting of the designated color. Wands or appropriate colored lens flashlights shall be used for night operations.

MANEUVERING

The fueling course and speed will be determined by the OTC. Variations in speed assume more importance than steering a steady course when an escort is fueling astern of a tanker. Because receiving ship judgment of relative speed and distance is more difficult in the astern methods than in abeam methods, great care must be taken in giving speed adjustments. Astern

Table 6-2.—Control Signals

SIGNAL		MEANING	
DAY	NIGHT	RECEIVING SHIP	DELIVERING SHIP
Green Flag	Green Light	Hose connected. Start pumping.	Pumping started.
Red Flag	Red Light	Stop pumping or blowing hose.	Pumping or blowing through has stopped.
White Flag	Amber Light	Blow down the hose	Blowing down started.

ueling can be carried out between 8 and 15 knots, vith the best normal speed being 12 knots.

In all cases, it is the responsibility of the tanker o maintain a steady course and speed as precribed by the OTC. The escort being refueled is esponsible for adjusting its course and speed to naintain correct station on the tanker.

During the fuel transfer phase of astern ueling, the receiving ship maintains a safe istance astern of the tanker by station keeping n a position buoy that is towed about 400 feet stern, to port, of the tanker. At that time, the eceiving ship's horizontal position, in relation to ne delivering tanker, is ideally about 40 feet utboard of a line extended aft from the tanker's tarboard beam (figure 6-24). That condition nould prevail in a relatively calm sea and with o adverse effect from sea or wind. Actually, tation keeping in a horizontal plane is a unction of maintaining station on the hose because, at times, wind and sea action prevent the hose from streaming directly astern of the tanker's stern roller.

The tanker should keep the escort informed of any alterations in course and speed. In the event of a major course change, the entire force should change course in 20-degree steps, with each fueling unit (tanker and astern replenishing ship) accomplishing each step in 5-degree increments. The tanker is the controlling ship for this maneuver. When the OTC signals to alter course 20 degrees, the master of the tanker will execute the following.

—Indicate commencement of each 5-degree increment by waving a flag (red for port turns, green for starboard turns) in a circular motion above the head.

—Hold the flag up and down when steady on each new 5-degree increment.

Table 6-3.—Summary of Float Method—Passing the Gear

DELIVERING SHIP	RECEIVING SHIP
. When ready for receiving ship to approach, hoist flag ROMEO close up.	1. Hoist flag ROMEO close up on the side where the hose will be received when commencing approach.
	2. Approach the spout float from astern.
	3. Grapple the hose line. This should be done at a distance from the float, not at the float itself.
	4. Haul in the hose line, and bring hose aboard.
. Haul down flag ROMEO when receiving ship hauls ROMEO down.	5. Haul down flag ROMEO when hose is on deck.
	6. Hang hose by inhaul line, and stop hose line to the guard rails.
	7. Remove conical cap, and connect up the hose.
. Acknowledge signal to start pumping.	8. When ready to receive oil, make hand signal to delivering ship, "Start pumping."
. Hoist flag BRAVO and start pumping.	9. As soon as oil starts to flow, hoist flag BRAVO.

—Hold flag in horizontal position, arm outstretched, on completion of the last 5-degree increment.

The commanding officer of the escort will execute similar signals to indicate the movements of his ship. During the course change, the escort will maintain its relative position astern by careful use of engine and rudder. The OTC should not order any subsequent alteration of 20 degrees until that person is satisfied that all units have steadied on the previously signaled course.

Alterations in speed by the tanker should b made in increments of one knot. The receivin ship keeps accurate station on the quarter of th tanker by keeping its bridge abreast a marker buo towed by the tanker and by staying about 40 fee clear of the tanker's wake. While picking up th hose, speed should be not more than 10 knots

SUMMARY OF FLOAT METHOD PROCE DURES. Tables 6-3 and 6-4 summarize procedure for passing the gear and disengaging. Complete de tails are given in NWP-14, *Replenishment at Sea*

Table 6-4.—Summary of Float Method—Disengaging

DELIVERING SHIP	RECEIVING SHIP
1. Stop pumping, on receipt of signal from receiving ship.	1. Hoist flag PREP at the dip 15 minutes before time of expected completion of refueling.
2. Blow through hose with compressed air.	2. When within about 500 gal (1.9 m^3) of the desired amount of fuel, signal "Stop pumping" to leave room for the fuel left in the hose to be blown through to the receiving ship by compressed air.
3. On receipt of signal, stop blowing through.	3. When hose is clear of oil, signal "Stop blowing through."
4. Haul down flag BRAVO.	4. Haul down flag BRAVO.
5. When conical cap has been replaced, inflate hose.	5. Hoist PREP close up.
	6. Disconnect hose and replace conical cap. Signal delivering ship when cap is replaced.
	7. Take weight on the easing-out line.
	8. Release the hose messenger from the fairlead block.
	9. Disconnect the inhaul line hook from the flounder plate link.
	10. Veer the hose while dropping astern.
	11. Cut hose line stops on guard rail, and let go.
	12. Haul down flag PREP, and proceed clear of delivering ship.

EMERGENCY BREAKAWAY-ASTERN FUELING. The general emergency breakaway procedures and requirements outlined for alongside refueling are applicable to astern fueling operations from a merchant tanker. In general, it is the responsibility of the escort in an emergency breakaway situation to expedite a normal breakaway or to use a sledge hammer to break the A-end of the breakable spool coupling. In making that determination, the receiving ship must weigh the advantages of recapping the hose prior to releasing the rig as opposed to the distinct hazard of a voluminous oil spill created when the coupling is broken with a head of liquid in the hose.

The delivery ship must be able to stop pumping instantly when there is an emergency or the "breakaway" order is given. In the event of a situation requiring emergency breakaway, the danger signal (at least five short blasts) shall be sounded on the ship's whistle by the ship initiating the emergency breakaway to alert all ships in the vicinity.

SAFETY REQUIREMENTS

Persons assigned to replenishment stations must be thoroughly schooled in safety precautions and should be so well trained that they observe them almost automatically. Unfortunately, people tend to be careless, particularly when doing familiar tasks. For this reason, personnel at each station must be briefed on safety precautions before each replenishment exercise. Following is a list of general replenishment safety precautions:

1. Only essential personnel should be allowed at transfer stations during replenishment.

2. Lifelines should not be lowered unless absolutely necessary; if lowered, temporary lifelines of at least 2-inch manila must be erected.

3. When a line-throwing gun is used, the procedures outlined in the "approach" section must be followed.

4. Topside personnel engaged in handling stores or lines or in the transfer area for any reason must wear properly-secured, orange-colored, inherently buoyant, vest-type lifejackets. Forklift operators will wear inflatable lifejackets.

5. Persons involved in replenishment must wear color-coded, Navy approved safety helmets, with chin strap fastened. The color code follows.

WHITE	Officers, CPOs, and other supervisors
YELLOW	BM in charge of station
GREEN	Signalmen/phone talkers
BROWN	Winch operators
PURPLE	Auxiliary repair personnel
RED	Line-throwing gunners and bolo heavers
WHITE (WITH RED CROSS)	Corpsman
BLUE	Line handlers/deck riggers
ORANGE	Checkers/supply personnel
GREY	All other persons

6. Personnel must keep clear of bights, handle lines well inboard, stay at least 6 feet from blocks through which lines run, and refrain from stepping between a load and the rail.

7. Persons handling messengers, distance lines, and inhauls may wear gloves, and should use the hand-over-hand grip.

8. Personnel handling wire-bound or banded cases must wear gloves.

9. Personnel should carry an appropriate knife to be used for routine work and in the event of an emergency.

10. Personnel must keep clear of suspended loads.

11. Care must be taken to prevent cargo from shifting, thereby endangering personnel or material.

12. Span wires, whips, or wire highlines must be secured to winch drums by only one wire clamp to minimize the possibility of damage should an emergency breakaway be necessary.

13. Cargo handlers in UNREP ships must wear government-furnished safety shoes; those on receiving ships should also wear safety shoes.

14. To provide secure footing at transfer stations, lower the area with deck treads or nonskid paint.

15. Both ships must station a lifebuoy watch well aft on the engaged side. This watch will be equipped with two smoke floats and a 24-inch ring buoy fitted with a float light. The watch should also wear sound-powered phones connected with the bridge.

16. All hands must be instructed on the emergency and breakaway hazards.

17. Only manila highlines or approved synthetics may be used for transferring personnel.

18. All personnel handling petroleum must be made aware of the constant danger of fire and explosion and must be thouroughly trained in using firefighting equipment.

19. The only kind of matches permitted aboard ship are safety matches. Cigarette lighters are allowed only in authorized smoking areas.

20. The smoking lamp is out while transferring fuel. It never is lighted on an oiler's weather decks.

21. Asbestos suits and other necessary protective and firefighting equipment must be on hand and ready for instant use while transferring fuel.

22. All tools used around gasoline transfer stations, and all fittings on gasoline hoses must be of nonferrous metal.

23. Before transferring gasoline, a ground wire must be rigged between ships. When unrigging, the ground wire must not be disconnected until the hose clears the receiving ship.

24. Gasoline hoses must be blown down by an inert gas such as carbon dioxide.

25. Precautions on radio frequency hazards are to be observed.

26. Phone talkers on the intership phone lines should not fasten their neck straps.

27. Cargo handlers should not be allowed to step on or in cargo nets which are attached to a cargo hook.

28. Replenishment station personnel must wear a one-cell flashlight (or chemical light) and whistles during night replenishments.

29. Easing-out lines, when appropriate, m be rigged immediately upon rig hookup to prep for a possible emergency breakaway.

30. Line handlers must button sleeves remove all loose objects to keep them fr wrapping around or fouling lines.

VERTICAL REPLENISHMENT

Vertical replenishment (VERTREP) u helicopters to transport cargo and personnel fr one ship to another. When used to augm alongside UNREP, VERTREP reduces the ti normally required to replenish a force, redu the time that screening ships are off station, enhances the replenishment of dispersed units. small-scale replenishments VERTREP elimina the approach, hookup, and disconn time required in alongside transfers. Using t helicopters (H46), transfer rates of up to 180 sh tons per hour can be achieved, depending on type of receiving ship.

For VERTREP, the helicopter hovers o both the transferring and the receiving ships relative wind of 15 to 30 knots from 30 degrees either bow is optimum, but other winds are ceptable, depending on various conditions (fig 6-25). Downwind approaches and departures v an external load are dangerous and should avoided if possible.

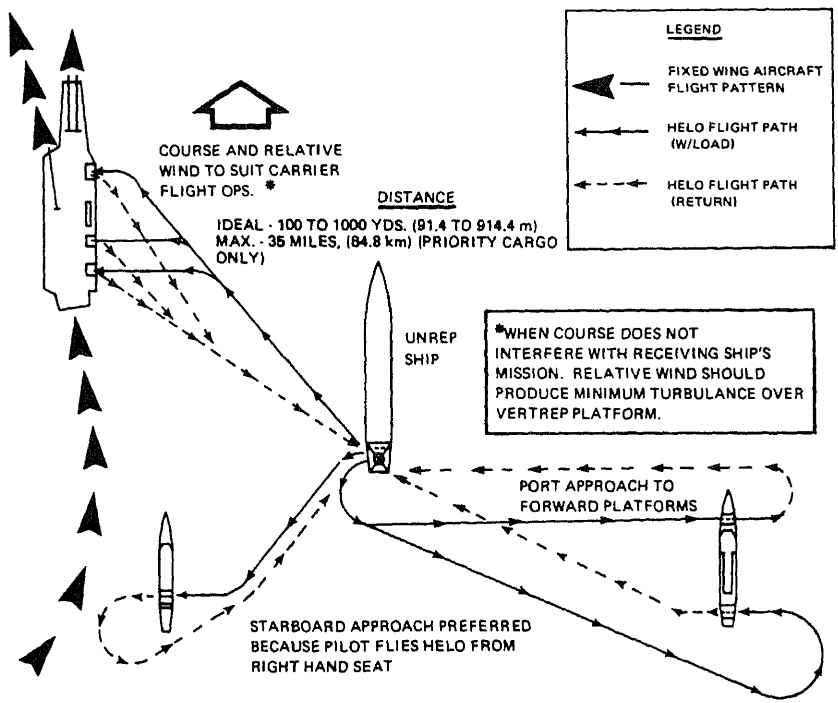


Figure 6-25.—Typical ship stations for VERTREP.

Because of the many publications and instruc-
ons relating to VERTREP, only a general scussion is provided in this section. Two basic ıblications are NWP 14, *Replenishment At Sea*, ıd NWP 42, *Shipboard Helicopter Operating rocedures*. Among the several instructions are ıose concerning certification of aviation facilities nonaviation ships, ordnance handling, general ight and operating instructions, UNREP hard-are and equipment, and aircraft accident porting procedures.

QUIPMENT

Much of the VERTREP cargo handling ıuipment is also used for UNREP; for example, ›rklift and pallet trucks, pallets, and cargo nets. ther items are peculiar to VERTREP operations, ıch as special cargo containers and hoisting ings.

rucks

Forklift trucks are the primary means of ansporting cargo to and from the staging area ›oard UNREP ships. Carriers and other ships ıat normally have forklifts use them to clear ırgo from the VERTREP area by suspending the ırgo net from raised forks.

Pallet trucks are used aboard receiving ships › move cargo from the drop area. They are ırried by UNREP ships and transferred to those ceiving ships able to use them. Normally they e the first load sent over and the last load turned.

argo Nets

Most VERTREP cargo is transported in nylon ets slung beneath the helicopter. The nets are ade of 1-1/2 inch nylon webbing and are 12 by 2 or 14 by 14 feet. A loaded pallet is placed the center of the net, which is then drawn › around the load. Rough treatment, such dragging a net across a flight deck, must e avoided or damage to the net will result.

allets

Pallets are 40 by 48 by 4-inch platforms of eel or wood. They are so constructed that they ay be lifted by a forklift from any side. Boxes ıd crates are stacked and strapped on the pallet, hich is then placed on a cargo net. Tubular steel pallets are designed to be nestable, thus reducing required stowage space.

Cargotainers

Cargotainers are steel pallets with wire mesh sides that fold down for compact storage. They are ideal for transferring loose and odd-shaped items. The sides of the cargotainer may be raised and locked before or after all the cargo is placed on the pallet. Light items near the top of the load must be strapped down or covered to prevent their being blown out during transfer.

PREPARATIONS/PROCEDURES

One to three days before the scheduled day, the delivery ship begins to break out, strike up, sort, and palletize cargo to be transferred. With the exception of chilled and frozen items, as much material as possible is assembled into loads and staged near the VERTREP area. Cargo is staged by destination and type within the specified area so as to be accessible to the hovering helicopter. Like cargo should be transferred load after load so that strikedown crews on the receiving ships need not be shifted back and forth. Usually, chilled and frozen cargo is broken out last and transferred first.

Pallets and nets should be loaded as heavily as safety permits. Small and lightweight articles should be placed on top of heavier items and covered with tarps or otherwise secured to keep them from blowing away. Complete loads should never be made up of such items as bulbs because the wind may blow light loads against the fuselage of the helicopter, damaging either the load or the aircraft or both. When possible, packages should be interlaced on a pallet. All palletized loads should be strapped or banded as tightly as possible. Previously banded loads should be checked and bands or straps added if needed.

Primary considerations in staging cargo are as follows:

1. Leave space in the center of the deck to roll out the helicopter and permit it to take off and land.
2. Stage cargo within the periphery lines so that it is accessible to the hovering helicopter.
3. Group loads for each customer ship so that they are accessible for pickup in the event of a change in schedule, and simultaneous multiship VERTREP is possible.

4. Stage cargo for each ship in a manner that will permit an orderly delivery sequence of like commodities (for example, all chilled and frozen loads first, then all dry stores, then all ammunition, and so on).

5. Leave room for the hookup person to move about and a route for escape from the area.

6. Locate loads over 3000 pounds where they can be picked up later in the delivery schedule when the helicopter has used some of its fuel and, thus, has a wider margin of power available when lifting the heavy loads.

Each load should be marked with its weight and destination. Because the most efficient load for helicopters presently being used for VERTREP is around 3000 pounds, light loads should be stacked together and paired for delivery. Paired loads should be approximately the same size and shape to reduce the possibility of their tipping when being picked up or landed. Depending on the space available on the receiving ship, up to four pallets may be transported at the same time.

As each load is picked up, its destination and weight are displayed on a hand-held blackboard from a position clearly visible to the pilot. If registered mail or classified material is included in the load, that fact is made known to the pilot. Voice radio may be used as an alternate method of communicating such information; but during daylight hours, radio transmissions should be kept to a minimum.

When the helicopter approaches the delivery ship, its approach is announced over the 1 MC. All hands clear the landing and pickup zone, except the hookup person, who takes position alongside the load and holds up the pole pendant to show the location of the load to the pilot. Guided by hand or flag signals from the landing signalman and by instructions from a member of the crew, the pilot maneuvers the helicopter over the load. As the helicopter hovers there, the hookup person slips the loop of the pendant over the cargo hook, then clears the area directly under the helicopter.

WARNING: The hookup person must never stand on the load or between the load being picked up and another load.

During the approach to the customer ship, the pilot lines up on the VERTREP approach lines and flies high enough to keep the load from dragging on the deck. Guided by the landing signalman, but at the same time flying so that any obstruction can be seen and avoided, the pilot maneuvers the helicopter over the ship. Once over the drop zone, the pilot follows a crewmember's directions to position the load over the landing spot. As soon as the load is on deck, the crewmember informs the pilot of that fact, and releases the cargo hook on signal or when the pendant slackens.

NOTE: A loaded helicopter should not be waved off just because the drop zone has not been cleared of the previous load. If space is adequate for additional drops, the load being worked should be secured temporarily by pulling the net over the load and threading a pendant leg through the beckets. All personnel then must clear the area while the next load is deposited.

As soon as the helicopter departs, cargo handlers clear the area. If pallet trucks have been furnished, most of the loads will be delivered on pallets with adjustable pallet slings, and it is a simple matter to jack up the pallets and haul them clear. Netted pallets can be moved with two pallet trucks, but cargo handlers should be prepared to break down loads by hand if a net interferes with the operation of the truck.

If no pallet trucks are furnished or they cannot be used, assigned personnel release the pendant hooks, open the net or cargo wraparound, and cut bands or unbuckle straps. The other personnel then move in and carry boxes from the zone. The last of them removes the pendant, empty pallet, and loose debris from the drop zone and places them in a staging area. Pallets are stacked and nets are folded to be returned later.

Empty pallets, nets, cargotainers, and pendants accumulating on the receiving ship take up space needed for cargo; besides, they are needed back on the delivery ship. Therefore, they must be assembled into loads and periodically returned to the UNREP ship.

Stack metal pallets, leaving the wraparounds connected. Secure pendants inside the load, saving one to hook up the load. Tighten the bottom wraparound over the group, and connect the pendant to the wraparound straps. If a net is used, stack the pallets on the center of the net and place the folded nets on top of the pallets. Draw the bottom net up around the pallets and other nets, and hook a pendant to the beckets. Four wooden or six metal pallets plus twelve cargo nets make a good stable load.

Cargotainers may be returned in nets or folded and placed in another cargotainer.

NIGHT VERTREP

Although night VERTREP procedures are essentially the same as during the day, not all ships are certified to conduct night operations except in emergencies. The final decision to conduct night VERTREP, even for certified ships, is left to the pilot.

Night cargo pickup and delivery require increased care and precision, and a wider flight pattern under low visibility condition. Delivery rates, therefore, are lower then they are during daylight. Other limiting factors are that the pilot's depth perception and visual reference are reduced, and crew fatigue is increased because of the extra vigilance required and the constant transition between visual flight and instrument flight.

Minimum ship lighting requirements are as follows:

1. The perimeter of the drop area should be clearly marked with red lights.
2. Obstructions in the vicinity of the drop should be illuminated.
3. Red flood lights should be focused on the flight deck at a point forward of the drop area.
4. A blue stern light should be used instead of a white light.
5. Ships should be ready at all times to adjust the intensity of all lights when requested to do so by the pilot.
6. All ships in the formation should show aircraft obstruction lights.

SAFETY

Preparation, organization, and the observance of all pertinent safety practices are, of course, essential to all shipboard evolutions. However, many nonaviation ships involved with helicopter operations are not fully aware of hazards peculiar to VERTREP operations. The rotor wash of a hovering helicopter, for example, can pick up all loose objects, including a 40- by 48-inch wooden pallet, in the vicinity of the drop area and turn them into dangerous, even lethal, missiles. All personnel involved in VERTREP, therefore, must be thoroughly indoctrinated in safety procedures.

The following precautions must be observed.

1. All personnel except the LSE (landing signals enlisted—directs the pilot from the flight deck or drop area) and the hookup person must clear the landing or drop area during takeoff, landing, or delivery.
2. The helicopter hookup person must wear a lifejacket and helmet with chin strap, goggles, and eye and ear protection. Loose articles of clothing should not be worn.
3. All personnel in the vicinity of the helicopter will remove their hats while the rotors are turning.
4. All personnel at the pickup or delivery area must be trained to take cover immediately on command of the officer (or petty officer) in charge.
5. Personnel working near the helicopter must be instructed to observe the aircraft carefully for any sign of malfunction, such as smoke, oil, hydraulic leaks, and so forth, and immediately report any such conditions to the helicopter pilot or to the VERTREP officer if the helicopter is airborne.
6. Ships participating in VERTREP operations must have a firefighting detail stationed at the transferring or receiving area. Personnel assigned to the helicopter crash/firefighting crew shall be properly clothed and shall not be assigned to any other duties.
7. Personnel must be instructed concerning the shrapnel effect caused when rotor blades strike a solid object and shatter. Spectators must be kept clear of the pickup or delivery area while VERTREP is in progress.
8. Personnel working as cargo handlers in the vicinity of helicopters must wear ear protective devices to guard against hearing damage because of high noise level.
9. All removable objects that might be damaged by swinging loads should be removed from the area.
10. The flight deck drop zone must be cleared of all objects that can be blown around by rotor wash or sucked into jet intakes.
11. Ships must not blow tubes or dump trash and garbage during VERTREP operations.
12. All hatches and covers near the drop zone must be closed.
13. Cargo handlers must not attempt to steady a load or to rush to the load before the helicopter has left the drop zone.
14. To minimize the danger to personnel and equipment during wet, rough weather, all staging

areas, drop zones, and paths leading thereto must have deck surfaces prepared and maintained to provide a nonskid quality.

15. The use of photo flashbulbs is prohibited during night VERTREP.

16. Communications on the VERTREP radio net should be kept to a minimum to prevent pilot distraction.

17. Do not place a netted load on another pallet for movement to the VERTREP area. When the helicopter lifts the load, the loose pallet could become a missile hazard.

18. Never attach a helicopter's hoist to the ship.

19. A minimum of four wood or six metal pallets, or an equivalent weight, must be used as a return load to preclude nets from blowing into the rotors.

CHAPTER 7

DAMAGE CONTROL

Our unending struggle to conquer the sea began in antiquity and continues to the present. This struggle is a story of courage, skill, perseverance, innovation, and pragmatism.

The sea has been and still remains an unrelenting adversary. Its calm and poetic beauty may turn with savage suddenness into a cauldron of overwhelming fury and destruction. Yet, we have learned to use the oceans and to move across their trackless miles to satisfy our insatiable curiosity about the most distant reaches of the planet. Discovery has gradually given way to utility, and the oceans have become the binding ties that unite the disparate land masses.

But the dangers are always there. Ships may be lost at sea through collision, by becoming stranded or foundered, and by burning. In a few cases, ships have mysteriously disappeared and are still missing. (See table 7-1.) The sea takes its toll.

Disaster can strike without warning as it did in New York harbor in 1973 when the CV *Sea Witch* lost steering control and collided with the SS *Esso Brussels*. The resulting fire killed 15 people, including both masters. Just as sudden was the still unexplained explosion of the *Berga Istra* in the Celebes Sea during 1975. The ship sank in 3 minutes; only two crew members who were thrown clear survived. Any ship that goes to sea must be prepared to cope with emergency situations.

In this chapter, naval damage control procedures will be presented. They differ from commercial practices for the same reason naval ships are constructed differently than merchant ships. That is, naval ships must be prepared to suffer damage inflicted by the enemy, remain afloat, and be able to fight back. However, the basic principles of damage control do not change. When a crew fights for their ship and their lives in the aftermath of a catastrophic incident, it matters little whether they are in the Navy or are merchant sailors. The task remains the same.

DAMAGE CONTROL OBJECTIVES

Damage control includes the functional combination of all equipment, material, devices, and techniques designed to prevent, minimize, or restore damage that occurs in wartime or peacetime. This includes passive defense for conventional, nuclear, biological, and chemical attack, and all active defense measures short

Table 7-1.—Summary of Merchant Ships Lost—All Nations 1967, 1971, 1975

	1967 No.	Gross Tons	% of Total	1971 No.	Gross Tons	% of Total	1975 No.	Gross Tons	% of Total
Foundered	87	133,571	16.04	129	180,871	17.6	125	189,174	19.0
Missing	15	23,133	2.78	7	22,102	2.1	4	13,939	1.4
Burned	49	147,039	17.65	56	227,707	22.1	61	322,131	32.4
Collision	34	62,436	7.50	43	83,977	8.2	34	119,107	11.9
Wrecked*	146	464,608	55.79	121	433,215	42.0	107	315,428	31.7
Lost, etc.**	6	2,016	0.24	21	82,688	8.0	5	35,472	3.6
TOTAL	337	832,803	100.0%	377	1,030,560	100.0%	336	995,261	100.0%

*Stranded, striking rocks or other submerged objects.

**Here, for want of sufficient information or other reasons—cannot be classified more specifically.

Source Lloyd's Register of Shipping, Casualty Return, Statistical Summary of Merchant Ships Totally Lost, Broken Up,

of those designed to prevent successful delivery of enemy attack by military means or sabotage.

The three basic objectives of shipboard damage control are to accomplish the following:

1. Take all practicable preliminary measures to prevent damage
2. Minimize and localize such damage as does occur
3. Accomplish, as quickly as possible, emergency damage repairs, restoration of equipment, and the care of injured personnel

These objectives are attained by the following:

1. Preserving stability and fume and watertight integrity (buoyancy)
2. Maintaining the operational capability of vital systems
3. Preventing, isolating, combating, extinguishing, and removing the effects of fire and explosion
4. Detecting, confining, and removing the effects of radiological, biological, or chemical contamination
5. Preventing personnel casualties and aiding in the care of the injured
6. Making rapid repairs to structure and equipment

The damage control organization has the same objectives in peacetime and wartime, although the threat is accentuated in periods of war. Its effectiveness will depend upon the ship's ability to perform its assigned mission.

PREPARATIONS TO RESIST DAMAGE

Naval ships are designed to resist accidental and battle damage. Damage-resistant features include structural strength, watertight compartmentation, stability, and buoyancy. Maintaining these damage-resistant features and maintaining a high state of material and personnel readiness before damage are far more important for survival than any damage control measures that can be taken after the ship has been damaged. It has been said that 90 percent of the damage control needed to save a ship takes place before the ship is damaged, and only 10 percent can be done after the damage has occurred. In spite of all precautions and all preparatory measures, however, the survival of a ship sometimes depends upon prompt and effective damage control measures taken after damage has occurred. Therefore, all shipboard personnel should be trained in damage control procedures.

The maintenance of watertight integrity is a vital part of any ship's preparations to resist damage. Each undamaged tank or compartment aboard ship must be kept watertight if flooding is not to be progressive after damage. Watertight integrity can be lost in a number of ways. Failure to secure access closures and improper maintenance of watertight fittings and compartment boundaries, as well as external damage to the ship, can cause loss of watertight integrity.

The condition of watertight boundaries, compartments, and fittings is determined by visual observation and by various tests, including chalk tests and air tests. All defects discovered by any test or inspection must be remedied immediately.

DAMAGE CONTROL SYSTEMS

A variety of built-in damage control systems or features makes a ship more resistant to natural or battle damage.

STRUCTURAL FEATURES

The success of damage control depends in part upon the proper use of the watertight integrity features of the ship. Compartmentation is a major watertight integrity feature of a naval ship. The ship is divided into compartments to control flooding, to strengthen defense against NBC attack, to segregate activities, to provide underwater protection by means of tanks and voids, to strengthen the structure of the ship, and to provide a means of controlling buoyancy and stability.

Every naval ship is divided by decks and bulkheads, both above and below the waterline, into as many watertight compartments as are compatible with the mission of the ship. In general, increasing the amount of compartmentation increases the ship's resistance to sinking.

MATERIAL CONDITIONS OF READINESS

Material conditions of readiness refer to the degree of access and system closure that limits the extent of damage to the ship. Maximum closure is not maintained at all times because it would interfere with the normal operation of the ship.

For damage control purposes, naval ships have three material conditions of readiness, each condition representing a different degree of tightness and protection. The three material conditions of readiness are called X-RAY, YOKE, and ZEBRA. These titles, which have no connection with the phonetic alphabet, are used in all spoken and written communications concerning material conditions.

Condition X-RAY, which provides the least protection, is set when the ship is in no danger from attack, such as when it is at anchor in a well-protected harbor or secured at a home base during regular working hours.

Condition YOKE, which provides somewhat more protection than condition X-RAY, is set and maintained at sea. It is also maintained in port during wartime and at other times in port outside of regular working hours.

Condition ZEBRA is set before the ship goes to sea or enters port during wartime. It is also set immediately, without further orders, when general quarters stations are being manned. Condition ZEBRA is also set to localize and control fire and flooding when the ship is not at general quarters stations.

The closures involved in setting the material conditions of readiness are labeled as follows:

X-RAY, marked with a black *X*. These closures are secured during conditions X-RAY, YOKE, and ZEBRA.

YOKE, marked with a black *Y*. These closures are secured during conditions YOKE and ZEBRA.

ZEBRA, marked with a red *Z*. These closures are secured during condition ZEBRA.

Once the material condition is set, no fitting marked with a black *X*, a black *Y*, or a red *Z* may be opened without permission of the commanding officer (through the damage control assistant or the officer of the deck). The repair party officer controls the opening and closing of all fittings in his assigned area during general quarters.

Additional fitting markings for specific purposes are modifications of the three basic conditions. These markings are described in the following paragraphs.

CIRCLE X-RAY fittings, marked with a black *X* in a black circle, are secured during conditions X-RAY, YOKE, and ZEBRA. CIRCLE YOKE fittings, marked with a black *Y* in a black circle, are secured during conditions YOKE and ZEBRA. Both CIRCLE X-RAY and CIRCLE YOKE fittings may be opened without special authority when going to or securing from general quarters, when transferring ammunition, or when operating vital systems during general quarters; but the fittings must be secured when not in use.

CIRCLE ZEBRA fittings, marked with a red *Z* in a red circle, are secured during condition ZEBRA. CIRCLE ZEBRA fittings may be opened during prolonged periods of general quarters, when the condition may be modified. Opening these fittings enables personnel to prepare and distribute battle rations, open limited sanitary facilities, ventilate battle stations, and provide access from ready rooms to flight deck. When open, CIRCLE ZEBRA fittings must be guarded for immediate closure if necessary.

DOG ZEBRA fittings, marked with a red *Z* in a black *D*, are secured during condition ZEBRA and during darken ship condition. The DOG ZEBRA classification applies to weather accesses not equipped with light switches or light traps.

WILLIAM fittings, marked with a black *W*, are kept open during all material conditions. This classification applies to vital sea suction valves supplying main and auxiliary condensers, fire pumps, and spaces that are manned during conditions X-RAY, YOKE, and ZEBRA. It also applies to vital valves that, if secured, would impair the mobility and fire protection of the ship. These items are secured only as necessary to control damage or contamination and to effect repairs to the units served.

CIRCLE WILLIAM fittings, marked with a black *W* in a black circle, are normally kept open (as WILLIAM fittings are), but they must be secured as defense against NBC attack.

PIPING SYSTEMS

Aside from those integral to the engineering plant, various piping systems provide essential damage control functions. These include firemain, exterior water-washdown, sprinkling and compartment flooding, ballast and deballast, and the several different drainage systems. All are built to withstand damage to the highest practicability as well as to allow easy maintenance. Features to attain these qualities include a high degree of sectionalization (with the location of flanges and cut-valves planned to assist dismantling), bends or flexible couplings, avoidance of unnecessary high and low points, valves designed and placed for ease of operation, remote valve operating

tations, and valve locking devices. The entire rew must be familiar with these systems, apabilities, and operating characteristics to rovide correct and timely relief in the event of n emergency.

POWER DISTRIBUTION SYSTEM

The power distribution system is the connect- ng link between the generators that supply lectric power and the electrical equipment that ses this power to furnish the various services ecessary to operate the ship. The power distribu- on system includes the ship's service power istribution system, the emergency power distribu- on system, and the casualty power distribution ystem.

Most ac power distribution systems on naval hips are 450-volt, three-phase, 60-cycle, three- ire systems. The lighting distribution systems are 15-volt, three-phase, 60-cycle, three-wire systems upplied from the power circuits through ansformer banks. On some ships, the weapons ystems, some IC circuits, and aircraft starting ircuits receive electrical power from a 400-Hz ystem.

HIP'S SERVICE POWER

The ship's service power distribution system the electrical system that normally supplies lectric power to the ship's equipment and achinery. The switchboards and associated enerators are located in separate engineering paces to minimize the possibility that a ngle hit will damage more than one switch- oard.

The ship's service generators and distribution witchboards are interconnected by bus ties that any switchboard can be connected to ed power from its generator to one or more f the other switchboards. The bus ties also onnect two or more switchboards so that the enerator plants can be operated in parallel or the switchboards can be isolated for plit-plant operation).

At least two independent sources of power are rovided for selected vital loads through utomatic bus transfer equipment. The normal nd alternate feeders to a common load run from ifferent ship's service switchboards and are ocated below the waterline on opposite sides of he ship to minimize the possibility that both will e damaged by a single hit.

EMERGENCY POWER

The emergency power distribution system supplies an immediate and automatic source of electric power to a limited number of selected vital loads in the event of failure of the ship's service power distribution system. The emergency power system, which is separate and distinct from the ship's service power distribution system, includes one or more emergency distribution switchboards. Each emergency switchboard, supplied by its associated emergency generator, has feeders which run to the bus transfer equipment at the distribution panels or loads for which emergency power is provided.

The emergency generators and switchboards are located in separate spaces from those containing the ship's service generators and distribution switchboards. As previously noted, the normal and alternate ship's service feeders are located below the waterline on opposite sides of the ship. The emergency feeders are located near the centerline and higher in the ship (above the waterline). This arrangement provides for horizontal separation between the normal and alternate ship's service feeders and vertical separation between these feeders and the emergency feeders, thereby minimizing the possibility of damaging all three types of feeders simultaneously.

The emergency switchboard is connected by feeders to at least one and usually to two different ship's service switchboards. One of these switchboards is the preferred source of ship's service power for the emergency switchboard, and the other is the alternate source. The emergency switchboard and distribution system are normally energized from the preferred source of ship's service power. If both the preferred and the alternate sources of ship's service power fail, the diesel-driven emergency generator starts automatically, and the emergency switchboard is automatically transferred to the emergency generator.

When the voltage is restored on either the preferred or the alternate source of the ship's service power, the emergency switchboard is automatically retransferred to the source that is available (or to the preferred source if voltage is restored on both the preferred and the alternate sources). The emergency generator must be manually shut down. Hence, the emergency switchboard and distribution system are always energized either by a ship's service generator or by the emergency generator. Therefore, the

emergency distribution system can always supply power to a vital load if both the normal and the alternate sources of the ship's service power to this load fail. The emergency generator is not started if the emergency switchboard can receive power from a ship's service generator.

A feedback tie from the emergency switchboard to the ship's service switchboard is provided on most ships. The feedback tie permits a selected portion of the ship's service switchboard load to be supplied from the emergency generator. This feature assists starting up the machinery after major alterations and repairs and provides power to operate necessary auxiliaries and lighting during repair periods when shore power and ship's service power are not available.

CASUALTY POWER

The casualty power distribution system is provided for making temporary connections to supply electric power to certain vital auxiliaries if the permanently installed ship's service and emergency distribution systems are damaged. The casualty power system is not intended to supply power to all the electrical equipment in the ship, but it is confined to the facilities necessary to keep the ship afloat and to get it away from a danger area. The system also supplies a limited amount of armament, such as antiaircraft guns and their directors, which may be necessary to protect the ship when in a damaged condition. The casualty power system for rigging temporary circuits is separate and distinct from the electrical damage control equipment, which consists of tools and appliances for cutting cables and making splices for temporary repairs to the permanently installed ship's service and emergency distribution systems.

The casualty power system includes portable cables, bulkhead terminals, risers, switchboard terminals, and portable switches. Portable cables in suitable lengths are stowed in convenient locations throughout the ship. The bulkhead terminals are installed in watertight bulkheads so that the horizontal runs of cables can be connected on the opposite sides to transmit power through the bulkheads without the loss of watertight integrity. The risers are permanently installed vertical cables for transmitting power through the decks without impairing the watertight integrity of the ship. A riser consists of a cable that extends from one deck to another with a riser terminal connected to each end for attaching portable cables.

DAMAGE CONTROL COMMUNICATIONS

Damage control communications are of vital importance to the damage control organization. Without adequate communications between different parts of the organization, the whole organization could break down and fail in its primary functions.

In general, you will find some or all of the following methods used for damage control communications: (1) sound-powered battle telephone circuits, (2) interstation two-way intercoms, (3) ship's service telephones, (4) ship's loud speaker or general announcing system, (5) voice tubes (where installed), and (6) messengers.

RESPONSIBILITY FOR DAMAGE CONTROL

Every member of the ship's company must realize individual responsibility toward damage control and the importance of the subject. The importance of efficient damage control cannot be overemphasized, and the desired state of readiness can only be achieved by a firm program stimulated by effective and dynamic leadership and executed by enthusiastic, well-trained, and determined officers and crew from all departments aboard each ship. While no area can be fully covered, the basic responsibilities of key individuals toward damage control are set forth in the succeeding paragraphs.

COMMANDING OFFICER

Within chapter 7, *U.S. Navy Regulations, 1973*, which delineates the various broad responsibilities of the commanding officer, are the requirements that he. . . "maintain his command in a state of maximum effectiveness for war service. . . ." and that he "Immediately after a battle or action, repair damages so far as possible, (and) exert every effort to prepare his command for further service. . . ."

To carry out this charge, the commanding officer must ensure that the command is adequately trained and continually exercised in all aspects of damage control. The CO should be fully aware of all of the ship's weaknesses in this area, including the adequacy and operability of all damage control equipment. Shortages and defects must not be tolerated; they should be immediately rectified.

:XECUTIVE OFFICER

The executive officer keeps the command dvised of the status of the ship's damage ɔntrol readiness. He carries out the requirements f command regarding damage control training nd the ship's readiness to combat all casualties nd damage resulting from a hostile act or other ccurrence, in wartime or peacetime, that ıreatens the ship. The executive officer must be ıtimately familiar with damage control evolu- ons; and he maintains overall supervision of all :tions incident to damage control, including rills, from a prescribed and distinct vantage oint.

'FFICER OF THE DECK

The officer of the deck (OOD), as senior ıember of the underway watch team, is the rimary assistant to the commanding officer on ıe bridge. To properly perform his duties, he ıust be intimately familiar with the ship, its ıaterial condition, and established procedures for nergencies. With respect to damage control rocedures, he should know and understand the ɔrrect course of action, or options, for various tuations. He should be prepared to promptly ıalyze a situation and take prompt, positive, and ɔrrect counteraction. The OOD could possibly ɛ on the bridge in the absence of the command- ıg officer and in the position of having to ıaneuver the ship during a serious fire, ɔmpounded by explosions. His ability to react :operly and promptly will be directly propor- onal to his knowledge of the ship, damage ɔntrol procedures, equipment available, and the aining he has received.

NGINEER OFFICER

The engineer officer is responsible, under .e commanding officer, for the operation, care, ıd maintenance of the main propulsion plant, ıxiliary machinery, and piping systems; for the ɔntrol of damage; for the operation and aintenance of electric power generators and stribution systems; for repairs to the hull; and ɔr repairs to material and equipment of other ɛpartments that are beyond the capacity of those ɛpartments but within the capacity of the ıgineering department.

DAMAGE CONTROL ASSISTANT

The damage control assistant (DCA), who is under the engineer officer, is responsible for establishing and maintaining an effective damage control organization. Specifically, the DCA is responsible for the prevention and correction of damage, the training of ship's personnel in damage control, and the operation, maintenance, and care of certain machinery, drainage, and piping systems not specifically assigned to other departments or divisions.

DAMAGE CONTROL ORGANIZATION

The damage control organization is the means by which the objectives of damage control can be attained. In fact, organization is the key to successful damage control. The damage control organization establishes standard procedures for handling various kinds of damage, and it sets up training procedures so that every person should immediately know what to do in each emergency situation.

Both the preventive and the corrective aspects of damage control are vitally important. The preventive aspects of damage control require the efforts of all departments in establishing material conditions of readiness, in training personnel, and in maintaining the ship in the best possible condition to resist damage. To achieve these ends, the ship's damage control organization must be coordinated with other elements of the ship's organization. In each department, therefore, specific damage control duties must be assigned to individuals in each division; this includes the designation of a division damage control petty officer. The corrective (or action) aspects of damage control require the damage control battle organization to promptly restore the offensive and defensive capabilities of the ship.

There are actually two damage control organizations: the damage control administrative organization and the damage control battle organization. The damage control administrative organization is an integral part of the engineering department organization. However, each department has major administrative and preventive maintenance responsibilities that are fulfilled

within its normal administrative organization. The damage control battle organization includes damage control central and various repair parties. The damage control battle organization varies somewhat from one ship to another, depending upon the size, type, and mission of the ship. However, the same basic principles apply to all damage control organizations.

BATTLE ORGANIZATION

The damage control battle organization includes damage control central (DCC); repair parties for hull, propulsion, electronic, weapons, and air; and battle dressing stations. This organization is based on the following principles:

- Each person within the organization must be highly trained in all phases of damage control along with the technical aspects of his rating field to assist in the control of damage.

- The organization must be decentralized into self-sufficient units each in communication with the other, and be capable of positive action in control of the types of damage likely to be encountered.

- One central station receives reports from all damage control units, and evaluates and initiates those orders necessary for corrective action from a shipwide point of view. It also reports to and receives orders from commands concerning matters affecting buoyancy, list, trim, stability, watertight integrity, and CBR defense measures.

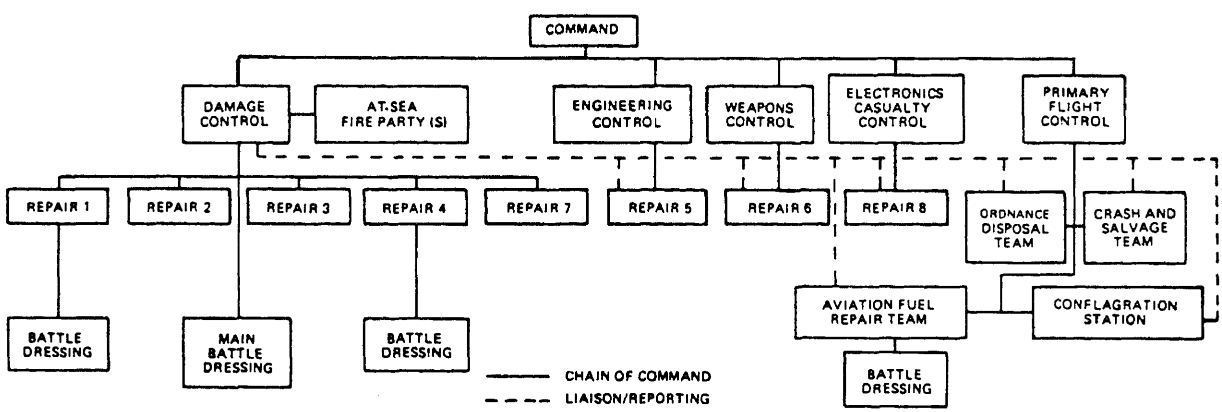
- Damage control units assigned to work peculiar to a single department are under the direct supervision of an officer of that department.

- Provision must be made for relief of men engaged in arduous tasks, for battle messing, and for transition from one condition of readiness to another. In this respect, procedures shall be in effect to ensure all relief crews are kept apprised of the overall situation, thereby assuring continual and proper action to combat the casualty.

- Provision must be made for positive, accurate, and rapid communications between all damage control parties, fire-fighting parties, or similar groups, so that overall coordination of effort and direction can be readily accomplished.

- Provisions must be made for the repair party remotely located from DCC to assume the functions of DCC in the event incapacitating battle damage is sustained by DCC.

The battle station for the DCA normally is DCC. The primary damage control battle organization units, shown in figure 7-1, are repair parties or teams. Battle dressing stations should be provided in close proximity, where appropriate.



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DAMAGE CONTROL CENTRAL

Personnel in DCC, under direction of the DCA, perform the following tasks:

- Receive and evaluate information from all repair parties.

- Inform command of conditions affecting the material condition of the ship, including buoyancy, list, trim, stability, and watertight integrity.

- Initiate orders to repair parties, as necessary, to direct control of damage.

- Keep command apprised of progress in combating damage, fire, flooding, the effects of NBC attack, and when feasible, the extent of significant personnel casualities. Evaluate the necessity of flooding magazines endangered by fire and make recommendations to the commanding officer, and act upon those orders issued by the commanding officer pertaining to the flooding of magazines.

- Control watertight integrity, flooding, counterflooding, and dewatering.

- Maintain the following material as described:

CHARTS and DIAGRAMS posted and suitably labeled to show the subdivisions of the ship and its systems.

A CASUALTY BOARD posted to show visually the damage sustained by the ship and corrective action in progress, as obtained from reports by repair parties.

A STABILITY BOARD posted to show the liquid loading, the location of flooding boundaries, the effect of list and trim caused by flooded compartments, and the corrective action taken with regard to stability. A liquid loading and flooding effects diagram may best be used for this purpose.

A LIST of ACCESS routes for ready shelter, deep shelter, electronic casualty control, and battle dressing.

GRAPHIC DISPLAYS to show action taken to correct damage control and electrical systems.

DECK plans to indicate areas contaminated by NBC agents, the locations of battle dressing stations, decontamination stations, and safe routes to them.

A CLOSURE LOG to show the state of closure of the ship.

NBC CONTAMINATION PREDICTION PLOT. Provision should be made for an alternate DCC. This station may be one of the repair party stations, engineering control, or secondary engineering control. The station designated must have facilities for fully communicating with all sections of the ship.

A simplified schematic should be maintained on the bridge for visual reference by command on casualty data reported by DCC.

REPAIR PARTIES AND TEAMS

Repair party officers take charge of activities in their area of responsibility after damage is sustained, keeping DCC informed of the situation. Certain repair parties may be subdivided, or prescribed functions may be the joint responsibility of two or more repair parties when necessary. When subdivisions of repair parties are created, they are designated by the number of the parent party followed by a letter (for example, 1-A, 1-B).

Composition

The composition of repair parties must permit each party to handle damage and casualties that may occur within its assigned area(s). Each shop shall designate a repair party as secondary DCC; in addition, a complete succession to command of damage control will be issued and posted in each repair locker. Physical location of each locker, seniority of repair locker officer, and communication facilities available should be considered in designating succession to command. The general composition given in the following paragraphs is considered necessary.

REPAIR 1 (MAIN DECK REPAIR PARTY)—An officer or chief petty officer from a deck division is in charge. It is comprised of deck

petty officers and nonrated men, Storekeepers, Radiomen, Electrician's Mates, Hospital Corpsmen, and aviation details (except in aircraft carriers). Engineering petty officers may also be required.

REPAIR 2 (FORWARD REPAIR PARTY)—A suitably trained officer or chief petty officer is in charge. The party is comprised of petty officers of the deck and engineering branches, Electrician's Mates, Storekeepers, Hospital Corpsmen, and nonrated personnel.

REPAIR 3 (AFTER REPAIR PARTY)—Similar to Repair 2.

REPAIR 4 (AMIDSHIP REPAIR PARTY)—Similar to Repair 2.

REPAIR 5 (PROPULSION REPAIR PARTY)—An engineering department officer is in charge. The party is comprised of an electrical officer or senior Electrician's Mate and a broad cross section of engineering ratings. Emphasis on assignment of personnel to Repair 5 should be placed on fireroom/engine room takeover qualifications in deference to damage control qualifications.

REPAIR 6 (ORDNANCE REPAIR PARTY)—An officer or chief petty officer of the weapons department is in charge. The party is comprised of Gunner's Mates, Fire Control Technicians, and Electrician's Mates. This party may be divided into forward and after subgroups.

REPAIR 7 (GALLERY DECK AND ISLAND STRUCTURE REPAIR)—This repair party is designated in aircraft carriers and other types when necessary. A suitably trained officer is placed in charge; and the party is comprised of air, engineering, damage control, and other ratings.

REPAIR 8 (ELECTRONICS REPAIR PARTY)—An officer (EMO) or chief petty officer of the operations department is in charge. The party is comprised of Electronics Technicians, Sonar Technicians, Fire Control Technicians, and Electrician's Mates. This repair party works under electronics casualty control.

equipped for manned helicopter operations. On aircraft carriers, an officer or chief petty officer of the air department is in charge; the teams are comprised of air department personnel. On ships equipped for manned helicopter operations appropriate deck, engineering, and damage control personnel are assigned.

ORDNANCE DISPOSAL TEAM—This team is made up of specially trained personnel deployed aboard ships as required. The team is organized within and administered as a unit of the weapons department. The ordnance disposal team operates under the direction of the weapons officer except as specified in this publication to fit the pecularities of aircraft carriers.

AT-SEA FIRE-FIGHTING TEAM—All ships—less submarines, patrol and yard craft, mine craft, and small auxiliaries—will maintain at least one at-sea fire-fighting team. Smaller craft and ships whose complement will not permit formation of this team shall organize a fire party as appropriate.

Functions of Repair Parties

General functions of repair parties require that repair parties work in close coordination with each other. The following functions are common to all repair parties:

1. Each party must be capable of making repairs to electrical and sound-powered telephone circuits.

2. Each party must be capable of giving first aid and transporting injured personnel to battle dressing stations without seriously reducing the damage control capabilities of the repair party.

3. Each party must be capable of detecting, identifying, and measuring dose and dose-rate intensities from radiological involvement and surveying and decontaminating contaminated personnel and areas that may result, except where specifically assigned to another department as in the case of nuclear weapons accident/incident.

4. Each party must be capable of sampling and/or identifying biological or chemical agents and decontaminating areas and personnel affected

5. Each party must be capable of controlling and extinguishing all types of fires (figs. 7-2 and 7-3).

6. Each party must be organized to evaluate and report correctly the extent of damage in its area. In reporting damage, each party must maintain the following:

- Graphic display board showing damage and action taken to correct disrupted or damaged systems.

- Deck plans showing locations of CBR contamination, location of battle dressings and personnel cleansing stations, and safe routes to them.

- A casualty board for visual display of structural damage.

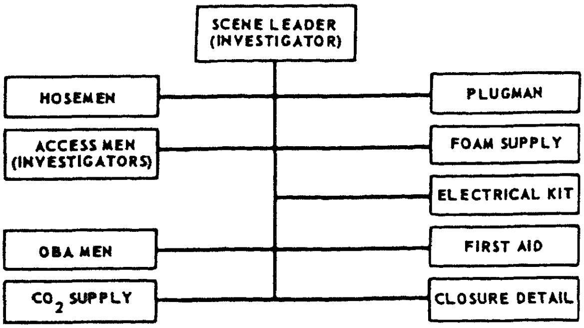

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Figure 7-2.—Organization of small fire-fighting party.

Specific Functions of Specified Repair Parties

The following specific functions are the responsibilities of the repair parties indicated.

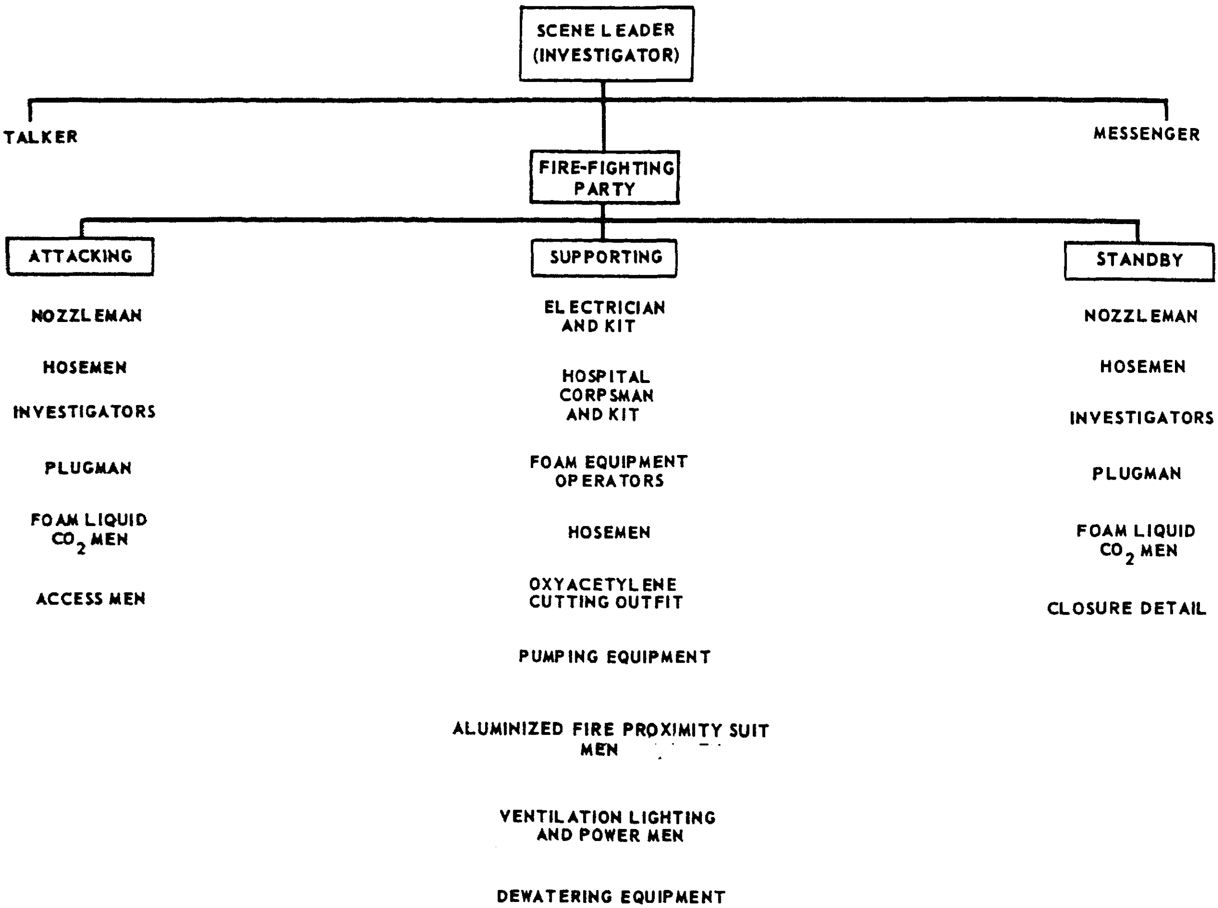

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Figure 7-3.—Organization of large fire-fighting party.

Maintenance of stability and buoyancy is the responsibility of Repairs 1, 2, 3, 4, and 5. These repair parties must be

- stationed so that they can reach all parts of the ship with a minimum opening of watertight closures;

- able to repair damage to structures, closures, or fittings that are designed to maintain watertight integrity, by shoring, plugging, welding, caulking the bulkheads and decks, resetting valves, and blanking or plugging lines through watertight subdivisions of the ship; and

- prepared to sound, drain, pump, counterflood, or shift liquids in tanks, voids, or other compartments, and be thoroughly familiar with the location and use of all equipment and methods of action.

For accurate evaluation of underwater damage, two status boards should be maintained. The Stability Status Board (Flooding Effects Diagram) is used for visual display of all flooding, flooding boundaries, corrective measures taken, and effects on list and trim. A Liquid Load Status Board is maintained to show the current status of all fuel and water tanks and the soundings of each tank in feet and inches.

Maintenance of the ship's structural integrity and maneuverability is the responsibility of Repairs 1, 2, 3, and 4. These repair parties must be able to accomplish the following:

- Make repairs to primary and auxiliary methods of steering

- Clear the upper decks of wreckage that interferes with operation of the battery, ship, or fire control stations or which fouls the rudder, propellers, or sides of the ship, and be ready to extinguish all types of fires

- Maintain and make emergency repairs to battle service systems, such as ammunition supply, ventilation supply, high- and low-pressure air lines, communications systems, electrical systems, and cooling water systems

- Provide emergency power to electrical equipment using casualty power cables

- Assist the crash and salvage team as required

- Stream and recover minesweeping equipment during general quarters

- Rescue survivors from the water and render assistance to other ships

- Repair above-water damage that would cause flooding in the event of further damage

Maintenance of ships propulsion is the responsibility of Repair 5, which must be able to accomplish the following:

- Maintain, make repairs, or isolate damage to main propulsion machinery and boilers

- Operate, repair, isolate, and modify the segregation of vital systems

- Assist in the operation and repair of the steering control systems

- Assist in the maintenance and repair of communications systems

- Assist Repairs 1, 2, 3, and 4 and the crash and salvage team when required

FUNDAMENTALS OF FIRE FIGHTING

Fire is a constant potential hazard aboard ship. All possible measures must be taken to prevent the occurrence of fire or to bring about its rapid extinguishment. In many cases, fires occur in conjunction with other casualties, such as those which result from enemy action, inclement weather, or an accident. Unless fire is rapidly and effectively extinguished, it may easily cause more damage than the initial casualty. In fact, fire may cause the loss of a ship even after the original damage has been repaired or minimized.

As a merchant marine officer, you will need to know a great deal about fire. You will have to know how to identify the different classes of fires, how to extinguish them, and how to use and care for fire-fighting equipment. You must also have a thorough understanding of the ship's systems that are important in connection with fire fighting. The more you learn about fires and fire fighting, the more effectively you will be able to contribute to the safety of your ship.

This section deals with the fundamentals of fire fighting, including the nature of fire, the

classification of fires, the fundamentals of extinguishment, and the extinguishing agents used.

WHAT IS FIRE?

Fire, also called burning or combustion, is a rapid chemical reaction that results in the release of energy in the form of light and noticeable heat. Most combustion involves very rapid OXIDATION; that is, the chemical reaction by which oxygen combines chemically with the elements of the burning substance.

Even when oxidation proceeds very slowly, as in the case of a piece of iron that is rusting, a small amount of heat is generated. However, this heat is usually dissipated before there is any noticeable rise in the temperature of the material being oxidized. With certain types of materials, slow oxidation can turn into fast oxidation (fire) if the heat is not dissipated. When this occurs, we say that SPONTANEOUS COMBUSTION has occurred. Such things as rags or papers soaked with animal or vegetable fats or with paints or solvents are particularly subject to spontaneous combustion if they are stowed in confined spaces where the heat of oxidation cannot be dissipated rapidly enough.

To have a combustible fuel or substance take fire, it must have an ignition source and it must be hot enough to burn. The lowest temperature at which a flammable substance gives off vapors that will burn when a flame or spark is applied is called the FLASH POINT. The FIRE POINT, which is usually a few degrees higher than the flash point, is the temperature at which the fuel will continue to burn after it has been ignited. The AUTOIGNITION or SELF-IGNITION POINT is the lowest temperature to which a substance must be heated to give off vapors that will burn without the application of a spark or flame. In other words, the autoignition point is the temperature at which spontaneous combustion occurs. The autoignition point is usually at a much higher temperature than the fire point.

The range between the smallest and the largest amounts of vapor in a given quantity of air that will burn or explode when ignited is called the FLAMMABLE RANGE or the EXPLOSIVE RANGE. (Say, for example, that a substance has a flammable or explosive range of 1 to 12 percent.) This means that fire or explosion can occur if the atmosphere contains more than 1 percent but less than 12 percent of the vapor of this substance. In general, the percentages referred to in connection with flammable or explosive ranges are percentages by volume.

It should be apparent by now that a fire cannot exist without three things: (1) a combustible material, (2) a sufficiently high temperature, and (3) a supply of oxygen. Because of these three requirements, the process of fire is sometimes regarded as being a triangle with the three sides consisting of FUEL, HEAT, and OXYGEN. As we will see presently, the control and extinguishment of fires is generally brought about by eliminating one side of the fire triangle—that is, by removing fuel, heat, or oxygen (fig. 7-4).

CLASSIFICATION OF FIRES

Fires are classified according to the nature of the combustibles (or fuels) involved. The classification of any particular fire is of great importance, since it determines the manner in which the fire must be put out. Fires are classified as being class A, class B, class C, or class D fires.

CLASS A fires are those occurring in such ordinary combustible materials as wood, cloth, paper, upholstery, and similar materials. Class A fires are usually extinguished with water in the form of high- or low-velocity fog or solid streams. Class A fires leave embers or ashes, and they must always be overhauled.

CLASS B fires are those occurring in the vapor-air mixture over the surface of flammable liquids such as gasoline, jet fuels, diesel oil, fuel oil, paints, thinners, solvents, lubricating oils, and greases. Dry chemical, foam, light water, carbon

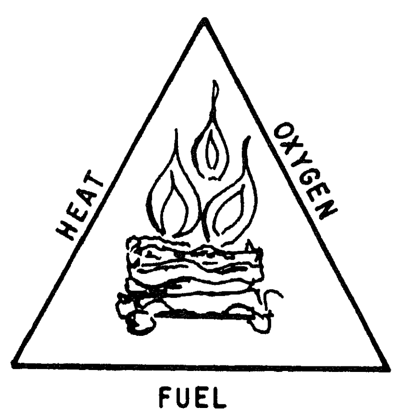

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Figure 7-4.—The fire triangle.

dioxide, or water fog can be used to extinguish class B fires; the choice of agent depends upon the circumstances of the fire.

CLASS C fires are those occurring in electrical equipment. Nonconducting extinguishing agents, such as dry chemicals and carbon dioxide, are used for extinguishing class C fires. Carbon dioxide is the preferred extinguishing agent because it leaves no residue.

CLASS D fires are those occurring in combustible metals such as magnesium, titanium, and sodium. Special techniques have been developed for the control of this type of fire.

PRINCIPLES OF EXTINGUISHMENT

In general, fires may be extinguished by removing one side of the fire triangle (fuel, heat, or oxygen) or by slowing down the rate of combustion. The method or methods of extinguishment used in any specific instance depend upon the classification of the fire and the circumstances surrounding the fire.

REMOVAL OF FUEL

Although it is not usually possible to actually remove the fuel to control a fire, there may be circumstances in which fuel removal is possible. If part of the fuel that is near or actually in a fire can safely be jettisoned over the side, this should be done as soon as possible. Damage control parties must stand ready at all times to shift combustibles to safe areas and to take whatever measures possible to prevent additional fuel from coming into contact with the fire. In particular, supply valves in gasoline and oil lines must be closed immediately.

REMOVAL OF HEAT

If enough heat can be removed by cooling the fuel to a temperature below that at which it will support combustion, the fire will go out.

Heat may be transferred in three ways: by radiation, by conduction, and by convection. In the process known as radiation, heat is radiated in all directions; it is radiated heat that causes you to feel hot when you stand near an open fire. In conduction, heat is transferred through a compartments. In convection, the heated air and other gases rising from a fire bring heat to all combustible materials within their reach. Heat transfer by convection is a particular danger in the case of ventilation systems, which may carry heated gases to places that are very far removed from the original fire.

To eliminate the heat side of the fire triangle, you must cool the fire by applying something that will absorb the heat. Although some other materials serve this purpose, water is the most commonly used cooling agent. Water may be applied in the form of a solid stream, as a fog, or incorporated into foam. The way in which the water or other cooling agent is applied depends upon the nature of the fire.

CONTROL OF OXYGEN

The third component of the fire triangle, oxygen, is difficult to control because we obviously cannot remove oxygen from the atmospheric air that normally surrounds a fire. However, oxygen can be diluted or displaced by other substances that are noncombustible so that extinguishment of the fire will occur.

If fire occurs in a closed space, it can be extinguished by diluting the air with carbon dioxide (CO_2) gas. This dilution of the air must proceed to a certain point before the flames are extinguished, but no fire can exist after this point has been reached. In general, a large enough volume of CO_2 must be used to reduce the oxygen content to 15 percent or less. The amount of oxygen normally present in air is about 21 percent.

Foam will also keep oxygen from reaching the burning materials, thus smothering the fire.

REDUCTION IN RATE OF COMBUSTION

Dry chemical fire extinguishing agents extinguish fires by a process that is not quite the same as removing one side of the fire triangle. It is believed that these agents achieve their extinguishing effects by interfering with the combustion reaction.

IMPORTANCE OF SPEED IN FIRE FIGHTING

Most fires start from quite small points of ignition, but they grow by leaps and bounds. If a fire is to be successfully extinguished, it must be done as rapidly as possible. Even a slight delay may cause the fire to grow beyond the control of available equipment.

EFFECTS OF FIRE

When a substance burns, a number of chemical reactions occur. These reactions result in the formation of flame, heat, and smoke. They also result in the production of a number of gases and other combustion products, and frequently they cause a reduction in the amount of oxygen available for breathing. All of these effects of fire are vitally important to the fire fighter, who must be prepared to protect himself against them.

FLAME, HEAT, AND SMOKE

To avoid injury or loss of life, fire fighters must protect themselves against flame, heat, and smoke. Before entering a compartment or area where a fire exists, the fire fighter should be in proper dress. Pant legs should be tucked into socks. The collar should be buttoned. The fire fighter should wear asbestos gloves, a helmet, a head lamp, and an oxygen breathing apparatus (OBA). The flame and the heat from a fire are intense, but proper dress will help to prevent burns. The smoke will make it hard to see and hard to breathe, but the OBA and the head lamp will help the fire fighter to cope with these problems.

COMBUSTION GASES

Some of the gases produced by a fire are toxic (poisonous); others are dangerous in other ways, even though they are not toxic. Some of the gases commonly produced by a fire are discussed briefly in the following paragraphs.

CARBON MONOXIDE is produced when fire occurs in a closed compartment or under other conditions in which there is not enough oxygen for the complete combustion of all the carbon in the burning material. Carbon monoxide, which has the chemical formula CO, is a colorless, odorless, tasteless, and nonirritating gas. It is DEADLY even in small concentrations. A person who is exposed to a concentration of 1.28 percent CO in air will become unconscious after two or three breaths and will probably die in 1 to 3 minutes. Carbon monoxide is also very dangerous because of its very wide explosive range. If carbon monoxide is mixed with air in the amount of 12.5 to 74 percent by volume, an open flame or even a spark will set off a violent explosion.

CARBON DIOXIDE (CO_2) is a colorless, odorless gas that is formed by the complete combustion of the carbon in burning materials. CO_2 is not poisonous; its main danger to the fire fighter is that an atmosphere of carbon dioxide does not provide oxygen to breathe, and asphyxiation may result. The danger of asphyxiation is particularly great because carbon dioxide, being colorless and odorless, does not give any warning of its presence, even when it is present in dangerous amounts. Carbon dioxide does not support combustion, and it does not form explosive mixtures with any substances. Because of these characteristics, it is very useful as a fire extinguishing agent. It is also used for inerting fuel oil tanks, gasoline tanks, and similar spaces.

HYDROGEN SULFIDE (H_2S) is a colorless gas. In low concentrations, hydrogen sulfide smells like rotten eggs. Hydrogen sulfide is generated in some fires; it also occurs as the result of rotting foods, cloth, leather, and other organic materials. Air that contains 4.3 to 46 percent hydrogen sulfide is violently explosive in the presence of flame. Hydrogen sulfide is extremely poisonous if breathed, even in concentrations as low as 0.01 percent. Acute poisoning results from breathing hydrogen sulfide in larger concentrations; rapid unconsciousness, cessation of breathing, and death can occur in a very few minutes from breathing an atmosphere that contains from 0.07 to 0.10 percent hydrogen sulfide.

INSUFFICIENT OXYGEN

When a fire occurs in a closed compartment or similar space, an inadequate supply of oxygen for breathing may result. An enormous amount of oxygen is used by the fire itself, leaving relatively little oxygen for a person to breathe. The amount of oxygen normally present in the air is 21 percent, and human beings breathe and work best with this amount of oxygen. When only 17 percent oxygen is in the atmosphere, a person breathes a little faster and deeper. When there is only 15 percent oxygen, a person is likely to experience dizziness, a buzzing in the ears, a rapid heartbeat, and a headache. When the oxygen content falls to 9 percent, unconsciousness may occur. Death is likely to result when the oxygen content of the atmosphere is 7 percent or less.

EXTINGUISHING AGENTS

The agents commonly used by Navy fire fighters include water, foam, dry chemicals, and carbon dioxide (CO_2). The agent or agents used in any particular case depend upon the classification of the fire and the general circumstances (see table 7-2).

WATER

Cooling is the most common method of fire extinguishment, and water is the most effective cooling agent. Fortunately, water is usually available in large quantities. Of all the extinguishing agents now used by the Navy, water has the greatest capacity for heat absorption.

Table 7-2.—Fire-Fighting Chart

CLASS	COMBUSTIBLE INVOLVED	EXTINGUISHING METHOD	EXTINGUISHING AGENT (IN ORDER OF PREFERRED USE)
A	Woodwork, Bedding, Cloths Combustible stores	Cooling	1. Fixed water sprinkler 2. High velocity fog 3. Solid water stream 4. TAS/foam 5. PKP extinguisher 6. CO_2 extinguisher
A	Explosives Propellants	Cooling	1. Magazine sprinkler 2. High velocity fog 3. TAS/foam
B	Paints, spirits Flammable liquid stores	Smothering	1. CO_2 fixed flooding system 2. TAS 3. Foam 4. Installed sprinkler 5. High velocity fog 6. PKP 7. CO_2 portable 8. Halon 1301-installed system
B	Gasoline	Permanent smothering (Best) Temporary smothering (Second)	1. TAS 2. Foam 3. CO_2 Installed system 4. Water sprinkler system 5. PKP 6. Halon 1301-installed system
B	Fuel oil, JP5, DFM, Diesel oil, Kerosene	Permanent smothering (Best) Temporary smothering (Second)	1. TAS 2. Foam 3. PKP 4. Water sprinkler system 5. High velocity fog 6. CO_2 7. Halon 1301-installed system
C	Electrical and Electrical Apparatus	De-energize first to remove source of heat and for safety	1. CO_2 2. PKP 3. Water fog (high or low) 4. Halon 1301-installed system
D	Magnesium	Best method is by applying velocity water fog. However a violent reaction may result, so stay at a safe distance.	1. Jettison 2. High velocity fog
D	Sodium	Smothering. Never apply water for it will cause a violent explo- sion. CO_2 and PKP will mix with sodium to form a high toxic mixture.	1. Dry earth 2. Dry sand 3. Powdered graphite
D	Thermite	No known extinguishing agent	Jettison into sea.
D	Potassium, Titanium	Cooling (Best)	1. Jettison

Therefore, most burning substances can be cooled below their ignition points by the application of water.

Aboard ship, water is usually applied by means of the all-purpose nozzle. With the all-purpose nozzle, water may be applied as a solid stream, in the form of a high-velocity water fog, or in the form of a low-velocity water fog. In general, fog is preferred to the solid stream except when it is necessary to reach a fire that is some distance away or when the penetrating power of the solid stream is required. Under other circumstances, the fog is preferable because a given amount of water can absorb more heat when it is in the form of fog than it can when it is in the form of a solid stream. An additional advantage of fog is that it reduces the total amount of water that must be pumped into the ship to fight a given fire. Since all water used for fire fighting must be pumped overboard or otherwise disposed of, this is a definite advantage. In addition to cooling the fire, fog tends to smother the fire by displacing oxygen.

Because of the cooling capacity of the finely divided water particles, fog can be used successfully on oil fires as well as on class A fires. If fog is used on an oil fire, you should remember that there is great danger of reflash until the entire surface of the oil has been cooled below the flash point.

Water is not recommended as an extinguishing agent for electrical fires except as a last resort. When water is properly broken up into a fine spray by the nozzles operating at the designed pressure, the fog does not conduct electric current. But if the fire fighter should accidentally shift to a solid stream or accidentally touch the nozzle or the applicator to electrical equipment, there is great danger of electrical shock. In those rare instances in which it is necessary to use water fog to fight an electrical fire, the nozzle should not be advanced any nearer to the power source than is absolutely necessary for proper use of the fog pattern.

Water fog affords considerable protection to the fire fighter by forming a screen of water droplets between the fire fighter and the fire. This fog screen gives protection against the intense heat of the fire and thus gives the fire fighter a certain amount of maneuverability in attacking the fire. Water fog also tends to dilute or absorb various vapors and to wash fumes and smoke from the atmosphere. The fire fighter can help to clear smoke from the area by occasionally directing the fog pattern upward for a few seconds.

Before the fire fighter enters a burning compartment, he should reduce the heat and flame by a liberal application of water fog. The fog should be put into the compartment through doors and other accesses. In the early stages of a large fire, a good deal of the fog thus admitted will turn into steam. The steam will help to smother the fire. The fire fighter must remember to stand clear of openings, since there is likely to be a violent outward rush of hot gases that are displaced by the steam.

FOAM

Foam is a highly effective extinguishing agent for smothering large fires, particularly those in oil, gasoline, and jet fuels.

AIR FOAM or MECHANICAL FOAM is a thick, viscous, light, and stable material that floats on almost any liquid, including water. It is nontoxic, and it does not damage surfaces such as painted bulkheads. The air foam or mechanical foam consists of very small bubbles of air mixed into water that has had a small amount of foam-forming liquid added to it. Mechanical foam is capable of resisting attack by flame or heat. After the fire has been extinguished, the foam continues to seal off vapor from the surface. Foam blankets of 6 to 8 inches will last 6 to 8 hours, settling at the rate of 1 inch per hour. Some sweeping action or other mechanical process may be necessary to remove the foam.

The generation and production of mechanical foam aboard ship is accomplished by supplying a mixture of foam-forming concentrate in water, under pressure, to the mixing area of a nozzle, where air is drawn into the nozzle.

There are two types of mechanical foam: protein foam and nonprotein foam. The protein foam, also called low-expansion foam, in a 6-percent solution in water, produces a closely knit bubble structure having an expansion ratio of eight volumes of foam per volume of foam solution. This foam has a relatively rigid structure with high heat resistance.

Nonprotein foam, also called high-expansion foam, uses a total flooding concept to completely fill enclosed spaces within a matter of minutes. A 2-percent to 6-percent solution in water produces foam at ratios of 100 to 1,000 volumes of foam per volume of foam solution. This is approximately 12.5 to 125 times as much foam as that produced by the protein type of foam solution. The nonprotein, or high-expansion, foam does not provide as dense a blanket as

protein foam, and it is not quite as heat resistant. However, the nonprotein foam produces a much larger quantity of foam, which is sufficiently fluid to flow over, around, and under obstructions to enter otherwise inaccessible spaces; thus it can be used to extinguish fires anywhere in a compartment. At the present time, the nonprotein, or high-expansion, foam is still under test and development; it is not currently approved for shipboard use except on an experimental basis.

LIGHT WATER or aqueous film forming foam (AFFF) is a new synthetic, film-forming foam liquid designed for use in shipboard fire-fighting systems. This new agent is replacing protein foam on most naval ships. Used in foam-proportioning equipment for protein foam, it generates a white vapor blanketing foam lighter than protein foam. In addition, it is equivalent to seawater as a fire-fighting agent on class A fires.

The unique action of light water stems from its ability to make a light-water film float on flammable fuels. As foam is applied over the flammable liquid surface, an aqueous solution drains from the foam bubbles and floats out over the surface to provide a vapor seal. This aqueous film-forming action enhances extinguishment and prevents reflash, even when the foam blanket is ruptured. Fuels that have not been ignited may also be secured for a short period of time with this same action.

Light water can be used alone or in combination with Purple-K-Powder (PKP) (covered in the section on dry chemicals). Mixing of light water and protein concentrate is not recommended, but both agents may be used simultaneously on the same fire after they have been discharged from their respective foam-generating system.

DRY CHEMICALS

Dry chemical powders extinguish a fire by a rather complicated chemical mechanism. They do not smother the fire, and they do not cool it. Instead, they interrupt the chemical reaction that is fire by suspending fine particles in the fire. In effect, the dry chemicals put a temporary screen between the heat, oxygen, and fuel and maintain this screen just long enough for the fire to be extinguished.

Several types of dry chemicals have been used as fire extinguishing agents. For Navy use, the most important agent of this kind at present is potassium bicarbonate, also known as Purple-K-Powder or PKP. PKP is used for extinguishing class B and class C fires. It is very effective against these fires. However, it is both corrosive and abrasive and should be used on class C fires only in emergencies. PKP is primarily used in portable 20-pound extinguishers. It can also be used in conjunction with light water.

CARBON DIOXIDE (CO_2)

Carbon dioxide is a very effective agent for extinguishing fires by smothering them; that is, by reducing the amount of oxygen available for combustion. This smothering action of carbon dioxide is temporary. The fire fighter must remember that the fire can quickly rekindle if oxygen is again admitted to hot embers.

Carbon dioxide is a dry, noncorrosive gas that is inert when in contact with most substances. Carbon dioxide does not damage machinery or other equipment. Since it is a nonconductor of electricity, carbon dioxide can safely be used in fighting fires that might present electric shock hazards. However, the frost that collects on the horn of the carbon dioxide cylinder IS a conductor of electricity. Therefore, rubber gloves should be worn by personnel using CO_2 to extinguish electrical fires.

Aboard ship, carbon dioxide fire-extinguishing equipment include 15-pound CO_2 extinguishers, 50-pound CO_2 hose and reel installations, and 50-pound CO_2 installed flooding systems.

Although carbon dioxide is nonpoisonous, it is dangerous to the fire fighter because it does not provide a suitable atmosphere for breathing. Asphyxiation can result from breathing carbon dioxide. OBAs must be worn when CO_2 is used below decks or in confined spaces.

HALON 1301

This section will provide the basic information on Halon 1301 with regard to safety, background, description, and function of the gas.

For most fires, a Halon concentration as little as 5 to 7 percent is capable of extinguishing a wide variety of flammable liquid and surface-burning solid fuels and of controlling deep-seated fires in flammable solids. Halon 1301 systems are designed to achieve and distribute a 5- to 7-percent concentration evenly throughout the space upon complete discharge of the agent and to hold this concentration in the space for a minimum of 10 minutes. Moreover, this fast-acting, colorless,

odorless, electrically nonconductive, heavier-than-air gas is just the thing to be used as a last-ditch effort against most class A (flammable solids), class B (flammable liquids), and class C (electrical) fires.

NOTE: Halon 1301 has not been found effective on the following:

1. Certain chemicals or mixtures of chemicals, such as cellulose nitrate and gunpowder, which are capable of rapid oxidation in the absence of air
2. Reactive metals such as sodium, potassium, magnesium, titanium, zirconium, uranium, and plutonium
3. Metal hydrides
4. Chemicals capable of undergoing autothermal decomposition, such as certain organic perioxides and hydrazine

In addition, Halon is low in toxicity, does no damage to property, and leaves no mess behind to clean up. As a matter of fact, the National Fire Protection Association recognizes Halon 1301 as the only gaseous agent accepted for use in occupied areas. Because of its speed in extinguishing fires, it can even stop fire while you are exiting the space. It has been used in closed spaces for over 30 years without a single reported injury resulting from exposure to its vapor. Furthermore, the decomposition products from the fire itself, especially carbon monoxide, smoke, heat, and oxygen depletion, create a greater hazard than the heat decomposition products of Halon (for example, hydrogen bromide and hydrogen fluoride). In most fire situations where 1301 is used, Halon byproducts are often barely detectable to the nose. At harmful toxic levels, you will notice a noxious and irritating odor.

The term *Halon* was first coined in 1948 by the U.S. Army Corps of Engineers as a convenient means of identification. Halon is a shortened version of halogenated hydrocarbon. The U.S. Army devised a numbering system of identification, and chose Halon 1301 in 1948 as the ideal extinguishment. Halon 1301 proved to be safe, fast, and clean. In the early 1960s commercial activities used it in total flooding systems. Naval vessels employed Halon on a test basis in the early 1970s. Their major purpose has been to extinguish catastrophic fires in machinery spaces. By 1978, ocean minesweepers (MSOs) and new construction ships were equipped with Halon 1301 systems. Many other naval vessels have been backfitted with Halon systems. Today there are about 10,000 Halon 1301 systems in service worldwide. Halon 1301 complements the total shipboard fire-fighting system. It is used as the final line of defense after other alternatives have been considered, such as portable extinguishers and the twin agent fire-fighting system (AFFF and PKP). In machinery spaces, Halon 1301 and aqueous film forming foam (AFFF) used in combination provide a powerful punch to flammable liquid (class B) fires.

These systems are located in three major spaces—machinery spaces, flammable liquid and flammable gas storerooms, and versatile avionic shop test (VAST) spaces. In addition, there are three types of systems available—modular, manifold banked, and central storeroom. In the sense that Halon in VAST spaces is stored in a spherical container with piping going to multiple nozzles and an actuation system, VAST Halon may be classified as a modular system. Flammable storerooms typically are equipped with modular systems. Manifold banked systems are found in most machinery spaces. The major exception to this is the minesweepers. They use a central storeroom Halon setup. In machinery spaces, such as engine rooms or firerooms, you may find 1301 in one or more cylinders piped to discharge nozzles located at the overhead of the space. The discharge nozzles and piping take on different configurations, depending on what type of Halon system is installed.

Which type of Halon system you are likely to encounter varies according to ship type. Regardless of type or location, all Halon is stored in liquid form in nonshatterable steel storage cylinders and, with the heat of superpressurized nitrogen, is expelled as a gas. In machinery space Halon cylinders, it is superpressurized with nitrogen to 600 pounds per square inch (psi) at 70 °F. Nitrogen acts as a booster, ensuring rapid and complete discharge of all the extinguishing agent. If Halon in one of the cylinders exceeds 240 °F (or 265 psi at 70 °F), its rupture disk will break. This is a built-in safety feature that prevents cylinders from exploding.

Manually operated Halon systems may be lit-off with either local or remote pneumatic actuators (small CO_2 cylinders). These CO_2 cylinders also have a rupture disk feature. Their bursting range is between 2,650 psi and 3,000 psi at 70 °F. Actuation is triggered from within the space or outside and next to each main access to the space. Actuation stations for machinery spaces are located inside each main machinery room,

access trunk on the damage control deck. Other features of the system include automatic ventilation shutdown, actuation of local and remote predischarged alarms (for example, a red rotary beacon light and a loud horn), a 60-second discharge time delay, and a discharge alarm.

A soaking period of at least 15 minutes (5 minutes for FFG class ships only) is required to ensure the space has cooled and the fire will not reflash upon reentry. Admission of oxygen by opening a hatch or restarting ventilation will dilute the concentration while the fuel is at or above ignition temperature.

WARNING: Do not reenter the space where Halon has been used to extinguish the fire without oxygen-breathing apparatus (OBA). Wear OBA until the atmosphere is certified safe. Anyone suffering from the toxic effects of Halon 1301 vapor should immediately move or be moved to fresh air.

In summary, Halon 1301 works well as a total flooding system because of its speed, cleanliness, low toxicity, lack of total vision distortion, compactness, and cost. Moreover, 1301 has the lowest toxicity of the Halons currently in use. Very little agent is needed to put out most fires. And, when properly used, it's safe.

Halon, however, is far from perfect. Battle damage or other events allowing air into the space can result in loss of Halon from the space. There is no cooling effect associated with Halon; so, as long as hot surfaces or smoldering materials are present, reflash is possible. Another limitation is that Halon cannot be replenished during operation. Boiler fire extinguishment poses a danger of flashback or explosion within the boiler. Finally, the presence of Halon decomposition products adds to the already dangerous toxic substances in the space.

Halon 1301 systems are the only ones combining effective fire control with personnel safety. They are now installed on ships throughout the Navy.

SHIP STABILITY

A knowledge of certain principles of physics is essential for an understanding of stability. You should be familiar with such terms as volume, density, weight, center of gravity, force, and moments.

The volume of any object is determined by the number of cubic feet or cubic units contained in the object. The underwater volume of a ship is found by determining the number of cubic feet in the part of the hull below the waterline.

DENSITY

The density of any material, solid or liquid, is obtained by weighing a unit volume of the material. For example, if you take 1 cubic foot of seawater and weigh it, the weight is 64 pounds or 1/35 of a ton (1 long ton equals 2,240 pounds). Therefore, seawater has a density of 1/35 ton per cubic foot.

WEIGHT

If you know the volume of an object and the density of the material, the weight of the object is found by multiplying the volume by the density. Writing this in a formula, $W = V \times D$ (weight = volume times density).

When an object floats in a liquid, the weight of the volume of liquid displaced by the object is equal to the weight of the object. Thus, if you know the volume of the displaced liquid, the weight of the object is found by multiplying the volume by the density of the liquid. For example, if a ship displaces 35,000 cubic feet of salt water, the ship weighs 1,000 tons (35,000 cubic feet × 1/35 ton per cubic foot = 1,000 tons).

CENTER OF GRAVITY

The center of gravity (G) is the point at which all the weights of the unit or system are considered to be concentrated and have the same effect as that of all the component parts.

FORCE

A force is a push or pull. It tends to produce motion or a change in motion. A force may act on an object without being in direct contact with it. The most common example of this is the pull of gravity. Forces are usually expressed in terms of weight units, such as pounds, tons, and ounces.

The action of a force on a body is indicated in figure 7-5. An arrow pointing in the direction of the force is drawn to represent the force. If a number of parallel forces act on a body, they may be combined into one force equal to the sum of all forces acting in the same direction and so located as to produce the same effect. In figure 7-6, F_4 is the sum, or resultant of F_1, F_2, and F_3. ($F_4 = F_1 + F_2 + F_3$.)

Whether you consider the individual forces F_1, F_2, and F_3, or just F_4 alone, the action of these forces on the object will move the body in the direction of the force.

An equal force must be applied in the same line and in an opposite direction to F_4 to prevent motion or to keep the body at rest. The new force and F_4 will cancel each other and there will be no movement; the resultant force is zero.

MOMENTS

In addition to the size of a force and its direction of action, the location of the force is important. For example, if two persons of the same weight sit on opposite ends of a seesaw, equally distant from the support (fig. 7-7), the seesaw will balance. However, if one person moves, the seesaw will no longer remain balanced. The end of the seesaw holding the person farthest away from the support will move down because the effect of the force of his weight is greater than the other person's weight.

The effect of the location of a force is known as the MOMENT OF FORCE. It is equal to the force multiplied by the distance from an axis about which you want to find its effect. The moment of force is the tendency of the force to produce rotation, or to move the object around an axis. Since the force is expressed in terms of weight units, such as tons or pounds, and the moment is force times distance, the units for moment are expressed as foot-tons, foot-pounds, or inch-ounces. In figure 7-8 the moment of force F about an axis at point a is $F \times d$ (d being called the moment arm).

The moment of force can be measured about any point or axis; however, the moment differs in accordance with the length of the moment arm. It should be noted that the moment of force tends to produce rotary motion. In figure 7-8, for example, force F produces a clockwise rotation. If, at the same time, an equal and opposite force produces a counterclockwise rotation, there will be no rotation; the body is in equilibrium.

A special case of moments occurs when two equal and opposite forces acting on a body are NOT IN THE SAME LINE. These two forces rotate the body. This system of two forces, as

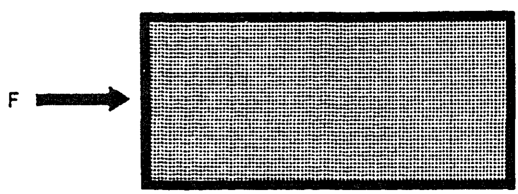

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Figure 7-5.—Indicating a force.

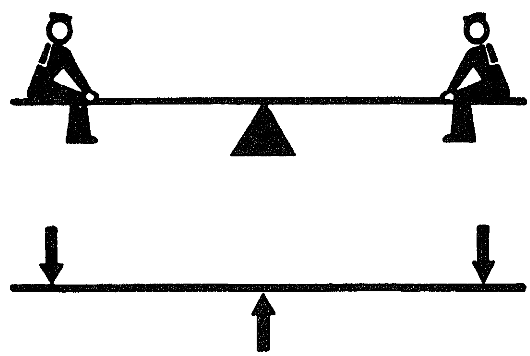

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Figure 7-7.—The seesaw.

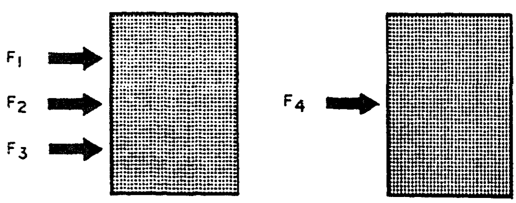

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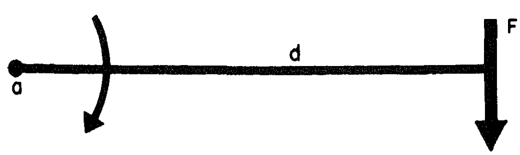
Figure 7-6.—The resultant of several forces.



8.38

Figure 7-8.—Diagram to illustrate moment.

illustrated in figure 7-9, is known as a COUPLE. The moment of the couple is the product of one of the forces times the distance between them. Thus, in the example shown in figure 7-10,

the moment = F × d, or 50 × 12 = 600 foot-pounds.

In one sense, a ship may be considered as a system of weights. If the ship is undamaged and floating in calm water, the weights are balanced and the ship is stable. However, the movement of weight on the ship causes a change in the location of the ship's center of gravity and thereby affects the stability of the ship. However, the movement of a ship does NOT affect the center of gravity.

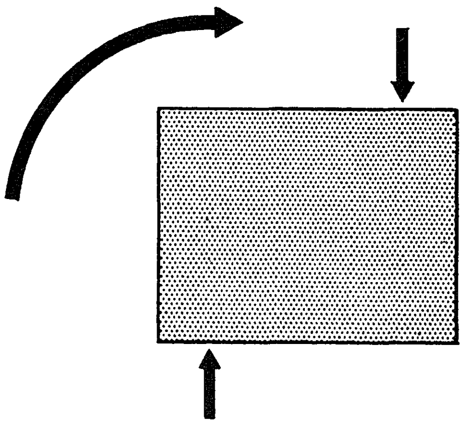


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Figure 7-9.—Equal and opposite forces acting on a body (not in the same line).

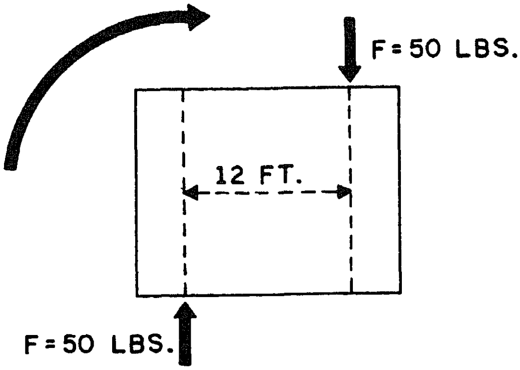

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Figure 7-10.—Diagram to show calculation of the moment of a couple.

Figure 7-11 shows how an INCLINING MOMENT is produced when a weight is moved outboard from the centerline of the ship. If the object weighing 20 tons is moved 20 feet outboard from the centerline, the inclining moment will be equal to 400 foot-tons (F × d or 20 × 20).

Figure 7-12 shows how a forward (or aft) movement of weight produces a TRIMMING MOMENT. Let's assume that a 20-ton weight is moved 50 feet forward; the trimming moment produced is 20 × 50, or 1,000 foot-tons.

It is also possible to calculate the VERTICAL MOMENT of any part of the ship's structure or of any weight carried on board. In calculating a vertical moment, use the ship's base line, or keel,

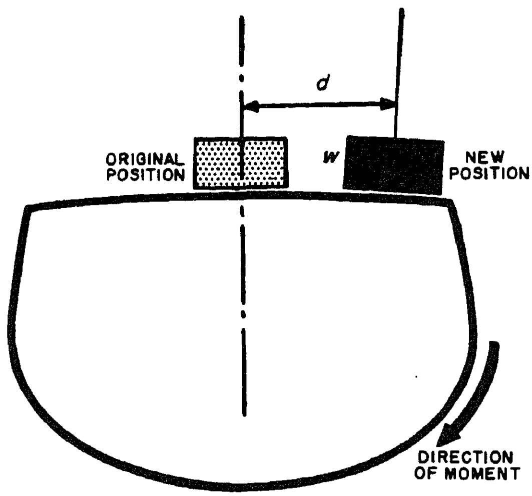

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Figure 7-11.—Inclining moment produced by moving a weight outboard.

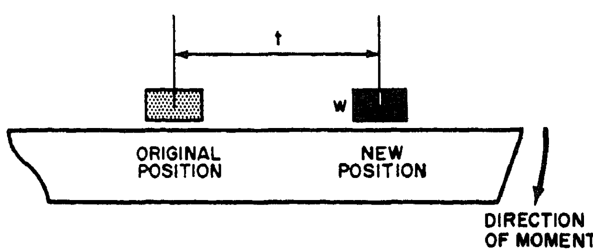

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Figure 7-12.—Trimming moment.

as the axis. Figure 7-13 illustrates the calculation of the vertical moment of a 5-inch gun on the main deck of a cruiser. The gun weighs 15 tons and is located 40 feet above the keel. The vertical moment is thus 15 × 40 = 600 foot-tons.

BUOYANCY VERSUS GRAVITY

Buoyancy may be defined as the ability of an object to float. Why do ships float? Well, let's assume that an object of a given volume is placed under water. If the weight of this object is GREATER than the weight of an equal volume of water, the object will sink. It sinks because the FORCE which buoys it up is less than the weight of the object. However, if the weight of this object is LESS than the weight of an equal volume of water, the object will rise. The object rises because the FORCE which buoys it up is greater than the weight of the object; it will continue to rise until it is partly above the surface of the water. In this position the object will float at such a depth that the submerged part of the object displaces a volume of water EQUAL to the weight of the object.

As an example, take the cube of steel shown in figure 7-14. It is solid and measures 1 foot by 1 foot by 1 foot. If you drop the steel cube into a body of water, the steel cube will sink because it weighs more than a cubic foot of water. But if you hammer this cube of steel into a flat plate 8 feet by 8 feet, bend the edges up 1 foot all around, and make the corner seams watertight, the 6-foot by 6-foot by 1-foot box, as shown in figure 7-14, will float. In fact, it will not only float but will, in calm water, support an additional 1,800 pounds.

It is obvious, then, that the volume of the submerged part of a floating ship provides the buoyancy to keep the ship afloat. If the ship is at rest, the buoyancy (which is the weight of the displaced water) must be equal to the weight of the ship. For this reason, the weight of a ship is generally referred to as DISPLACEMENT, meaning the weight of the volume of water displaced by the hull.

DISPLACEMENT

Since weight (W) is equal to the displacement, it is possible to measure the volume of the underwater body (V) in cubic feet and multiply this volume by the weight of a cubic foot of seawater to find what the ship weighs. This relationship may be written as follows:

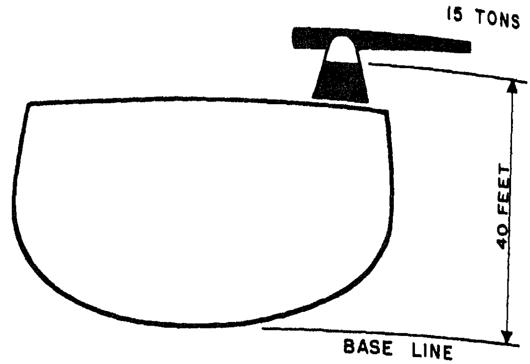

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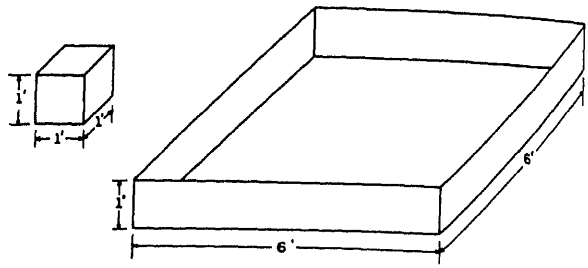
Figure 7-13.—Vertical moment.



8.44
Figure 7-14.—A steel cube and a box made from the same volume of steel.

$$(1)\quad W = V \times \frac{1}{35}$$

$$(2)\quad V = 35W$$

V = Volume of displaced seawater (in cubic feet)

W = Weight in tons

35 = Cubic feet of seawater per ton (When dealing with ships, it is customary to use the long ton of 2,240 pounds.)

It is also obvious, then, that displacement will vary with draft. As the draft increases, the displacement increases. This is indicated in figure 7-15 by a series of displacements shown for successive draft lines on the midship section of a cruiser.

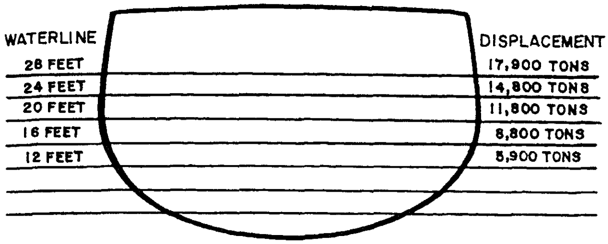


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Figure 7-15.—Displacement data.

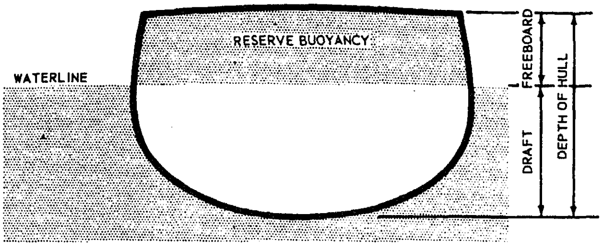

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Figure 7-16.—Reserve buoyancy, freeboard, draft, and depth of hull.

RESERVE BUOYANCY

The volume of the watertight portion of the ship above the waterline is known as the ship's reserve buoyancy. Expressed as a percentage, reserve buoyancy is the ratio of the volume of the above-water body to the volume of the underwater body. Thus, reserve buoyancy may be stated as a volume in cubic feet, as a ratio or percentage, or as an equivalent weight of seawater in tons. (In tons it is 1/35 of the volume in cubic feet of the above-water body.)

Freeboard, a rough measure of reserve buoyancy, is the distance in feet from the waterline to the weather deck edge. Freeboard is calculated at the midship section. As indicated in figure 7-16, freeboard plus draft always equals the depth of the hull in feet.

When weight is added to a ship, draft and displacement increase in the same amount that freeboard and reserve buoyancy decrease. It is essential to the seaworthiness of a ship to retain a substantial amount of reserve buoyancy.

INCLINING MOMENTS

A ship may be disturbed from rest by certain influences that tend to make it heel over to an angle, such as wave action, wind pressures, turning forces when the rudder is put over, recoil of gunfire, impact of a collision or enemy hit, shifting of weights on board, and addition of off-center weights. These influences, which exert heeling moments on the ship, may be temporary or continuous.

When a disturbing force exerts an inclining moment on a ship, there is a change in the shape of the ship's underwater body. The underwater volume is relocated, its bulk being shifted in the direction of the heel. This causes the center of buoyancy (B) to leave the ship's centerline and shift in the direction of the heel. (The center of buoyancy moves to the geometric center of the new underwater body.) As a result, the lines of action of the forces of buoyancy and gravity separate and, in doing so, exert a MOMENT on the ship. This moment tends to restore the ship to an even keel.

EFFECTS OF LOOSE WATER

With the ship's center of gravity and stability established, the damage controlman becomes concerned with the effects of flooding from hull damage or fire-fighting water.

When a tank or a compartment in a ship is partially full of liquid that is free to move as the ship heels, the surface of the liquid tends to remain level. The surface of the free liquid is referred to as FREE SURFACE. The tendency of the liquid to remain level as the ship heels is referred to as FREE SURFACE EFFECT. LOOSE WATER is a term used to describe liquid that has a free surface; it is NOT used to describe water or other liquid that completely fills a tank or compartment and thus has no free surface.

FREE SURFACE EFFECT

Free surface in a ship causes a reduction in the ability of a ship to right itself because of a change in the center of gravity and a consequent reduction in stability. The free surface effect is separate from and independent of any effect that may result merely from the addition of the weight of the liquid. When free surface exists, a free surface correction must be included in stability calculations. However, when a tank is completely

ed so that there is no free surface, the liquid the tank may be treated as a solid; that is, the ly effect of the liquid on stability is the effect its weight at its particular location.

To understand the actions that occur because free surface effect, use a centerline compart- nt that is partially full of water (as shown in . 7-17) as an example.

To begin with, the ship is floating on an even el at waterline WL. Then the compartment is oded to waterline WL. Assuming that the water ers the compartment instantaneously and that s instantaneously frozen solid, the effects of s frozen body of water are the same as if a solid ight had been added. The ship undergoes rallel sinkage and comes to rest at a new terline, W_1L_1.

Now suppose that an outside force acts on the p, causing it to heel over at a small angle of to a new waterline, W_2L_2. If at the same time liquid is freed from its frozen state, it will run vard the low side of the compartment until the face of the water in the compartment is parallel the existing waterline, W_2L_2. A wedge of uid is thus shifted from one side of the npartment to the other; as a result, the center gravity of the liquid is shifted from D to E. the center of gravity of the liquid is shifted board, an additional inclining moment is ated; this causes the ship to list to a new terline, W_3L_3.

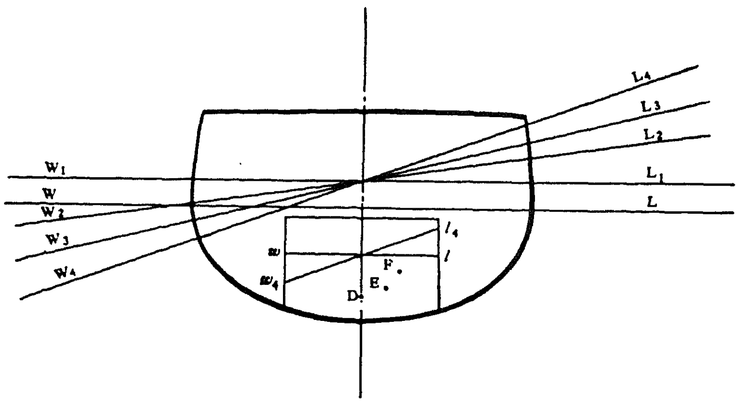
The additional list, in turn, causes a further t of the liquid in the compartment, and a ther shift of the center of gravity of the liquid. the center of gravity of the liquid shifts to another inclining moment is created and the lists even more. Eventually the ship will come est with a waterline such as W_4L_4; this will ur when the righting moment of the ship is equal to the combined effects of (1) the original inclining moment created by the outside force and (2) the inclining moment created by the shift of liquid within the compartment.

LOCATION OF FREE SURFACE

The free surface effect is independent of the location of the free surface within the ship. A free surface with a certain length and breadth will, at any given angle of heel, cause the same reduction in the ability of the ship to resist initial heel from the upright position (and, therefore, the same loss of stability), no matter where it is in the ship—forward or aft, high or low, on the centerline or off the centerline.

DEPTH OF LOOSE WATER

The free surface effect of a given area of loose water at a given angle of heel does NOT depend upon the depth of the loose water in the tank or compartment, unless the loose water is shallow enough or deep enough to cause the effect known as "pocketing" of the free surface. To understand how pocketing of the free surface reduces the free surface effect, study figure 7-18. Part A shows a compartment in which the free surface effect is NOT influenced by the depth of the loose water. The compartment shown in part B, however, contains only a small amount of water; when the ship heels sufficiently to reduce the waterline in the compartment from WL to W_1L_1, the breadth of the free surface is reduced and the free surface effect is thereby reduced. A similar reduction in free surface effect occurs in the almost full compartment shown in part C, again because of the reduction in the breadth of the free surface. As figure 7-18 shows, the beneficial effect of pocketing is greater at larger angles of heel.



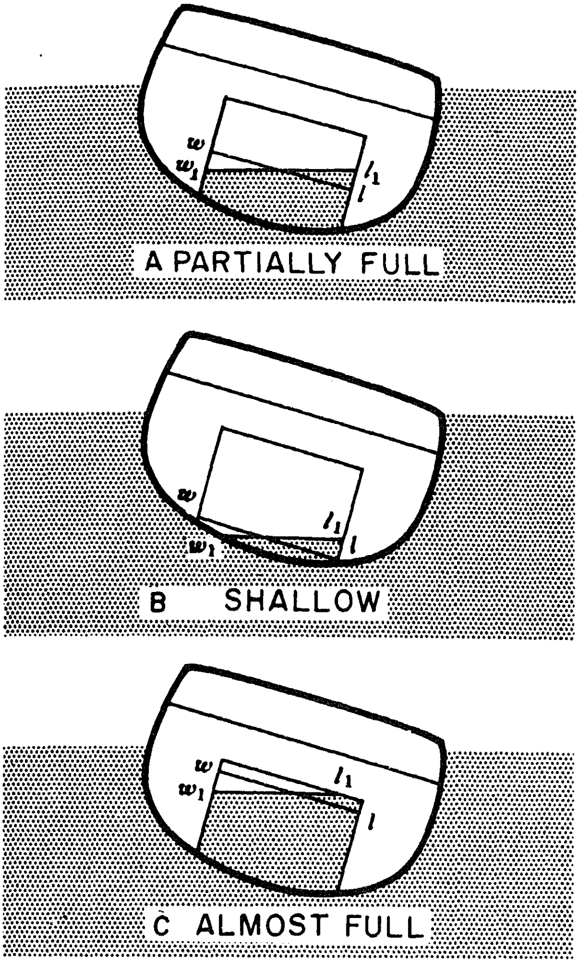


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Figure 7-18.—Diagram to illustrate pocketing of free surface.

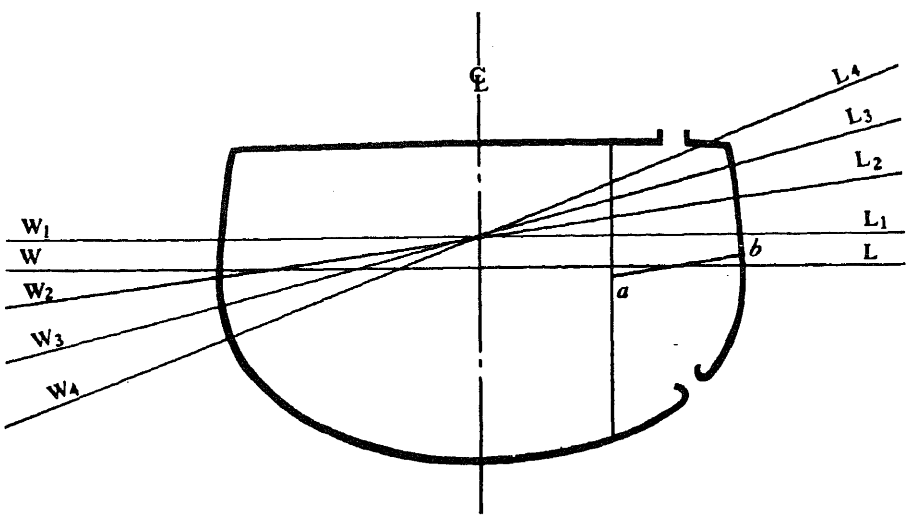
The reduction in free surface effect that results from pocketing is NOT taken into consideration when you are evaluating stability. Since pocketing improves stability, neglecting this factor in stability calculations provides a margin of safety; in centerline deep tanks on DD types where the tank is higher than it is wide, the opposite may be true.

The normal practice of maintaining the fuel oil tanks 95 percent full takes advantage of the fact that pocketing occurs, at very small angles of heel, when a compartment is almost full.

FREE COMMUNICATION EFFECT

Thus far, the stability changes caused by the effect of free surface and by the addition of the weight of the flooding water have been considered. In certain instances, it is also necessary to make allowance for stability changes that occur when an off-center compartment is in free communication with the sea.

If a boundary of an off-center compartment is so extensively ruptured that the sea can flow freely in and out as the ship rolls, the FREE COMMUNICATION EFFECT will cause a reduction in stability. Note that the free communication effect on stability is IN ADDITION TO the effect of free surface and the effect of added weight. To understand the free communication effect, consider an off-center compartment partially full of water and in free communication with the sea, as shown in figure 7-19. (Note that this compartment is free to vent at the top.)



8.63

Before the hull is ruptured, the ship floats on
ı even keel at waterline WL. Then the compart-
ent is partially flooded and left in free
mmunication with the sea. Assume that the
ater enters the compartment instantaneously
p to the level of the ship's original waterline
L) and is instantaneously frozen solid. If the
eight of the frozen water is distributed equally
out the ship's centerline, the ship will undergo
rallel sinkage to a new waterline, such as
$_1L_1$. Since the weight is off center, however,
e ship assumes an inclined position with a
aterline similar to W_2L_2.

If the water in the compartment is now
turned to its fluid state, it will have a waterline
-b) that is parallel to (but below) the ship's
aterline, W_2L_2. Immediately, however, addi-
onal water will flow in from the sea and flood
e compartment to the actual level of the ship's
aterline, W_2L_2. The ship will therefore sink
eper in the water and will assume a greater list;
e waterline will reach a position such as W_3L_3.
gain, additional water will flow in from the sea
d flood the compartment to the level of the
p's waterline, W_3L_3; this will cause the ship
sink even deeper in the water and to assume
even greater list. These interactions will con-
ue until the waterline is at the position
presented by W_4L_4.

Note that stability is not usually reduced
free communication if the compartment is
nmetrical about the ship's centerline. Under
tain circumstances, free communication in a
aterline compartment may increase the free
face effect and thereby reduce stability;
wever, it is important to remember that this
luction in stability occurs from the increased
e surface effect rather than from any free
nmunication effect.

MMARY OF EFFECTS LOOSE WATER

The addition of loose water to a ship alters
stability characteristics by means of three
ects that must be considered separately: (1) the
ect of added weight, (2) the effect of free
face, and (3) the effect of free communication.

Figure 7-20 shows the development of a
bility curve with corrections for added weight,
e surface, and free communication. Curve A
the ship's original stability curve before
oding. Curve B represents the situation after
oding; this curve shows the effect of added

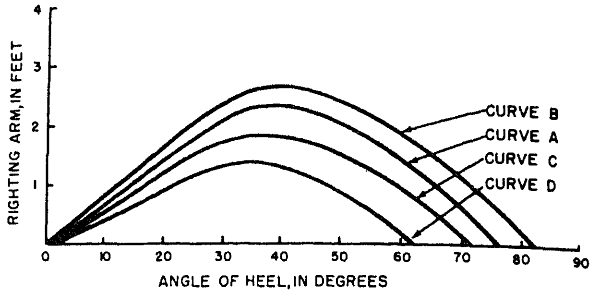


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Figure 7-20.—Development of stability curve connected for effects of added weight, free surface, and free communication.

weight (increased stability) but it does NOT show the effects of free surface or of free communication. Curve C is curve B corrected for free surface effect only. Curve D is curve B corrected for both free surface effect and free communication effect. Curve D, therefore, is the final stability curve; it incorporates corrections for all three effects of loose water.

LONGITUDINAL STABILITY

Thus far in studying stability, you have been concerned only with TRANSVERSE STABILITY and with TRANSVERSE INCLINATIONS; LONGITUDINAL STABILITY AND LONGITUDINAL INCLINATIONS or TRIM should also be considered.

Trim is measured by the difference between the forward draft and the after draft. When the after draft is greater than the forward draft, the ship is said to be TRIMMED BY THE STERN. When the forward draft is greater than the after draft, the ship is said to be TRIMMED BY THE BOW or TRIMMED BY THE HEAD. As a ship trims, it inclines about an athwartship axis that passes through a point known as the CENTER OF FLOTATION.

The mean draft that is used to enter the draft scale to read a displacement curve is the draft amidships. When a ship has trim, however, neither the draft amidships nor the average of the forward and after drafts will give a true mean draft. For most types of ships, the curves of form may be used without correction for trim, PROVIDED the trim is less than about 1 percent of the length of the ship. When the trim is greater, however, the readings obtained from the curves of form must be corrected for trim.

CORRECTIVE DAMAGE CONTROL

Even if all possible precautions are taken, there still may be a ship casualty that necessitates emergency action. In this case the ship's task can be divided into immediate local measures to be accomplished at the scene of the damage and overall ship survival measures.

IMMEDIATE LOCAL MEASURES

Immediate local measures are those actions taken by repair parties at the scene of the damage. In general, these measures include all on-scene efforts to investigate the damage, to report to damage control central, and to accomplish the following:

1. Establish flooding boundaries by selecting a line of intact bulkheads and decks to which the flooding may be held and by rapidly plugging, patching, and shoring to make these boundaries watertight and dependable
2. Control and extinguish fires
3. Establish secondary flooding boundaries by selecting a second line of bulkheads and decks to which the flooding may be held if the first flooding boundaries fail
4. Advance flooding boundaries by moving toward the scene of the damage, while plugging, patching, shoring, and removing loose water
5. Isolate damage to machinery, piping, and electrical systems
6. Restore piping systems to service by the use of patches, jumpers, clamps, couplings, and so on
7. Rig casualty power
8. Rig emergency communications and lighting
9. Rescue personnel and care for the wounded
10. Remove wreckage and debris
11. Cover or barricade dangerous areas
12. Ventilate compartments that are filled with smoke or toxic gases
13. Take measures to counteract the effects of nuclear, biological, and other chemical contamination or weapons

Immediate local measures for the control of damage are of vital importance. It is not necessary for damage control central to decide on these measures; rather, they should be carried out automatically and rapidly by repair parties. However, damage control central should be continuously and accurately advised of the progress made by each party so that the efforts of all repair parties may be coordinated to the best advantage.

OVERALL SHIP SURVIVAL MEASURES

Overall ship survival measures are those actions initiated by damage control central for the handling of list, trim, buoyance, stability, and hull strength. Operations in this category have five general objectives: improving GM and overall stability, correcting for off-center weight, restoring lost freeboard and reserve buoyancy, correcting for trim, and relieving stress in longitudinal strength members.

Improving GM and Overall Stability

The measures used to improve GM and overall stability in a damaged ship include (1) suppressing free surface, (2) jettisoning topside weights, (3) ballasting, (4) lowering liquid or solid weights, and (5) restoring boundaries.

Correcting for Off-Center Weight

Off-center weight may occur as the result of unsymmetrical flooding or as the result of an athwartship movement of weight. Correcting for off-center weight may be accomplished by (1) pumping out off-center flooding water, (2) pumping liquids across the ship, (3) counter-flooding, (4) jettisoning topside weights from the low side of the ship, (5) shifting solid weights athwartships, and (6) pumping liquids overboard from intact wing tanks on the low side.

Restoring Lost Freeboard and Reserve Buoyancy

Restoring lost freeboard and reserve buoyancy requires the removal of large quantities of weight. In general, the most practicable way of accomplishing this is to restore watertight boundaries and to reclaim compartments by pumping them out. Any corrective measure that removes weight from the ship contributes to the restoration of freeboard.

Correcting for Trim

The methods used to correct for trim after damage include (1) pumping out flood water,

2) pumping liquids forward or aft, (3) counter-flooding the high end, (4) jettisoning topside weights from the low end, (5) shifting solid weights from the low end to the high end, and (6) pumping liquids over the side from intact tanks at the low end. The first of these methods—that is, pumping out flood water—is in most cases the only truly effective means of correcting a severe trim.

The correction of trim is usually secondary to the correction of list, unless the trim is so great that there is danger of submerging the weather deck at the low end.

Relieving Stress in Longitudinal Strength Members

When a ship is partially flooded, the longitudinal strength members are subject to great stress. In cases where damage has carried away or buckled the strength members amidships, the additional stress imposed by the weight of the flooding water may be enough to cause the ship to break up. The only effective way of relieving stress caused by flooding is to remove the water. Other measures, such as removing or shifting weight, may be helpful but cannot be completely effective. In some instances, damaged longitudinals may be strengthened by welding.

BATTLE DAMAGE REPAIR

To repair battle damage, you must have an extensive knowledge of the available damage control equipment and materials, of the procedures for repairing holes in the hull, and of the procedures for using shoring. These topics are discussed in this chapter.

DAMAGE CONTROL EQUIPMENT AND MATERIALS

The equipment and materials required for making battle damage repairs vary according to the nature of the damage. Since many different kinds of damage can occur aboard ship, you must know how to use a variety of equipment and materials.

A typical repair locker usually contains some or most of the following equipment, depending upon the ship's allowance: oxygen breathing apparatus and six canisters for each OBA on the allowance, suits, tending lines, miner's lights, flashlights, sealed beam lights, battle lanterns, extension lights, sounding rods, helmets, life jackets, hand tools, electrical tools, chain hoist and straps, blocks and tackle, screw and hydraulic jacks, manila line, forcible entry tool, X-10J cable and jackboxes, oxygen indicator, combustible gas indicator (exploimeter), respirators, hose air-line masks, emergency cutting outfit, electrical kits, rubber boots, rubber gloves, spare electrical cable, steel wedges, hose and pipe flanges, hose and pipe adaptors, shoring kit and shoring batten, plugging kit, pipe patching kit (soft patches), blower sleeves, prefabricated patches, gas masks, protective clothing, NBC defense detection equipment and markers, decontamination equipment, fire rakes and ladders, foam nozzles, and extra fire hose.

On ships that have subgroups, some of this equipment is stowed in the unit lockers. Additional damage control equipment is dispersed throughout the ship in designated areas. This equipment includes portable gasoline-driven fire pumps and hose, fire hose, nozzles, applicators, foam proportioners, spare foam cans, CO_2 extinguishers, dry chemical extinguishers, portable blowers, shallow-water diving gear, submersible pumps, eductors, shoring chests, shoring materials, plate patches, battle lanterns, and casualty power cables.

RELIABILITY OF DAMAGE CONTROL EQUIPMENT

The damage control organization cannot function without an adequate supply of damage control equipment. You will have a great deal of responsibility for seeing that all damage control equipment is available and in good condition when it is needed. A regular program of checking damage control equipment should be set up and followed.

Checks should be made to see that all damage control equipment, tools, and materials on the allowance list are actually on board. To do this, you should compare the ship's allowance list with an accurate and up-to-date inventory of onboard damage control equipment.

Checks should be made to see that all damage control equipment is stowed or installed in its designated location and that it is readily accessible. Emergencies can be handled much more effectively if equipment is available than if you have to waste time looking for it.

The equipment assigned to each repair station should be identified in such a way that items can be returned to the appropriate repair station after

they have been used. A simple color-marking system can be used. All tools and other items of equipment that belong to any one repair station should be marked with a stripe, band, or spot of an identifying color.

Damage control equipment must NOT be used for any purpose other than damage control. Because damage control equipment is located throughout the ship, some people are tempted to use it merely because it is handy. This must NOT be allowed. It is important to make all hands realize that their lives may literally depend upon the ready availability of damage control equipment if an emergency should arise.

DAMAGE CONTROL KITS

At each repair locker, a number of repair kits are made up and stowed in canvas bags, ready to be taken to the scene of damage. The kits should be so constructed and packaged that they will fit through a watertight scuttle. These kits are commonly referred to as plugging kits, pipepatching kits, and shoring kits. The shoring kit is brought to the scene in addition to the shoring chest.

Each damage control kit should have a list of contents attached to the carrying strap. The list makes it relatively simple to inventory the contents of the kit. All damage control kits and repair locker equipment must be inventoried after each use and at prescribed intervals. Any missing equipment or material should be replaced as soon as possible. Extra plugging and pipe-patching kits are made up for the engineering spaces. These extra kits are inventoried and maintained by personnel assigned to the engineering spaces. All damage control kits should be identified by outside labeling.

RIGGING GEAR

Repair lockers have various kinds of rigging gear, such as chain falls, screw or hydraulic jacks, wire hawsers, blocks and tackle, and manila line. This gear is useful in clearing away wreckage, restoring equipment to its original position, and shoring. To a limited extent, rigging gear may be used to hold equipment in position. However, it should not be relied upon to do the work of shores. A jack may be used to push heavy weights back to their proper positions. Chain falls and blocks and tackle may be used to pull weights back into position or to hold equipment in place while shoring. Whenever equipment is being hoisted, the rigging gear must be secured to a stout padeye, beam, or strongback. If the weight is loose and free to move, check the motion with steadying lines.

PATCHING MATERIALS

A number of materials are available for plugging and patching and for covering and securing patches. Some of the materials commonly used for these purposes are mentioned here.

PLUGGING AND PATCHING MATERIALS include wooden plugs and wedges, wooden shoring, prefabricated wooden box patches in various sizes, rags, pillows, mattresses, blankets, kapok life jackets, metal plates, folding metal plate patches, flexible sheet metal patches, prefabricated steel box patches, bucket patches, and welded steel patches.

SECURING MATERIALS include assorted hook bolts, manila line, wire rope, chain, machine bolts, angle clips for welding, and shoring.

BACK-UP MATERIALS include mess tables, panel doors, buckets, plywood or lumber, and sheet metal.

GASKET MATERIALS include sheet and strip rubber, leather, canvas, rags, oakum, white lead, and paint.

HOLES IN THE HULL

Any rupture, break, or hole in the ship's outer hull plating, particularly below the waterline, can admit seawater. If flooding is allowed to go on uncontrolled, the ship will sink. When the underwater hull is pierced, there are only two possible courses of action. The first, obviously, is to plug the holes or openings. The second is to establish and maintain flooding boundaries within the ship to prevent further progress of the flooding. Only after these two measures have been taken can dewatering be effective.

One of the most important things to remember in connection with flooding is that a ship can sink just as easily from a series of small and insignificant looking holes as it can from one larger and more dramatic looking hole. A natural tendency, and one which can lead to the sinking of the ship, is for personnel to attack the obvious damage first and to overlook the smaller holes in the hull and in interior bulkheads. Personnel sometimes waste hours trying to patch large holes in already flooded compartments, meanwhile disregarding the smaller holes through which

progressive flooding is gradually taking place. In many cases, it would be better to concentrate on the smaller holes. As a rule, the really large holes in the underwater hull cannot be repaired anyway until the ship is drydocked.

All holes in the hull, large or small, should of course be plugged completely as soon as possible. As an interim measure, all holes should be partially plugged if they cannot be completely plugged. It is very important to remember that even a partial plug can substantially reduce the amount of water entering the ship and thus substantially reduce the danger of sinking.

Holes in the hull at or just above the waterline should be given immediate attention. Although holes in this location may not appear to be dangerous, they are actually very hazardous. As the ship rolls or loses buoyancy, the holes become submerged and admit water at a level that is dangerously high above the ship's center of gravity. These holes should be plugged at once; those at the waterline or on the low side should be given priority.

The methods and materials used to repair holes above the waterline are also used, for the most part, for the repair of underwater holes. Since the repair of underwater holes tends to be more difficult than the repair of holes above the waterline, any person who can repair underwater damage must certainly be regarded as being capable of repairing similar damage above the waterline. For this reason, most of the discussion in this chapter deals with repairing underwater damage.

FACTORS AFFECTING UNDERWATER REPAIRS

The two main factors that make it difficult to repair underwater holes are the pressure exerted in the water and the relative inaccessibility of the damage. The difficulties arising from water pressure are often exaggerated. Actually, a hole 7 feet below the waterline is only subjected to a water pressure of about 3 pounds per square inch.

Figure 7-21 shows the flooding effect of unplugged holes and of the same holes after the simplest of plugs are inserted. The volumes of flooding water are given in gallons and also in terms of the number of electric submersible pumps required to handle the flooding. It should be obvious that prompt plugging of holes is desirable to save the ship, to release pumps for use elsewhere, and to save wear and tear on the pumps in use. Note that the pump capacities used are considerably under the rated capacities (usually 180 GPM); but if the strainers are clogged with debris, the actual capacities may be much less than the rated capacities.

The greatest difficulty in repairing underwater damage is usually the inaccessibility of the damage. If an inboard compartment is flooded, opening doors or hatches to get to the damage would result in further flooding of other compartments. In such a case, it is usually necessary to send a person wearing a shallow-water diving outfit down into the compartment. The diver's repair work may be hampered by tangled wreckage in the water, the absence of light to work by, and the difficulties of trying to keep buoyant repair materials submerged.

PLUGGING AND PATCHING HOLES

The procedures discussed here for plugging and patching holes are intended for emergency use. They are temporary repairs that can be done while in action to keep the ship afloat. In most cases they do not call for elaborate tools or equipment; in general, they involve principles that can be applied when using wooden plugs, prefabricated patches, or other readily available materials are used.

Two general methods of making temporary repairs to holes in the hull are used: put something in it or put something over it. In either case, the effect is to reduce the area through which water can enter the ship or through which water can pass from one compartment to another.

Plugging

The simplest method of stopping up a fairly small hole is to insert some kind of a plug. Plugs made of soft wood, such as yellow pine or fir, are quite effective for stopping up holes up to

about 3 by 3 inches in size. Such plugs may sometimes be used for stopping up larger holes as well.

The plugging kit contains an assortment of plugs and wedges, together with the tools required to use them. The kit also contains oakum and rags. Tools contained in the kit include a maul or sledge, a hatchet, a crosscut wood saw, a cold chisel, a hammer, and a calking iron for working oakum or rags into leaky areas that remain after the plugs and wedges have been inserted.

The plugs and wedges may be used individually if they fit the hole. Often, however, it is best to use a combination of conical, square-ended, and wedge-shaped plugs to make

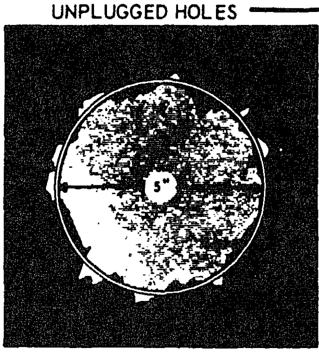
FOR COMPUTING THE AMOUNT OF WATER THAT COULD ENTER A SHIP THROUGH A HOLE IN THE HULL AT ANY ONE INSTANT IN TIME, YOU MAY USE THE FOLLOWING FORMULA:

$$.6\ A \quad 2GH = Q$$

WHERE Q = Cubic feet of water/sec
A = Area of hole in sq ft
G = Gravitational constant 32 ft/sec^2
H = Height of water in feet (depth of hole)

"PUMPS" ARE THE NUMBER OF ELECTRIC SUBMERSIBLE PUMPS REQUIRED TO HANDLE THE FLOODING

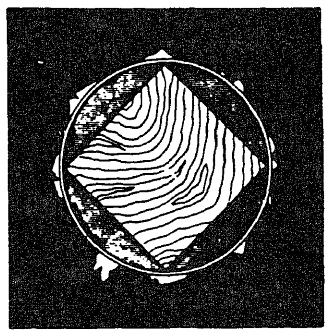
UNPLUGGED HOLES



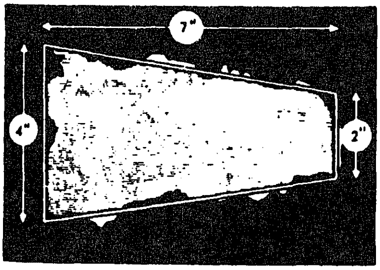
DEPTH IN FEET	GALLONS PER MINUTE	PUMPS
1	301	3
2	425	4
3	512	
4	603	5
5	676	6
6	739	
7	794	
8	853	7
9	904	

SAME HOLES PARTLY PLUGGED

DEPTH IN FEET	GALLONS PER MINUTE	PUMPS
1	114	1
2	160	
3	192	
4	227	2
5	254	
6	277	
7	286	
8	320	3
9	339	

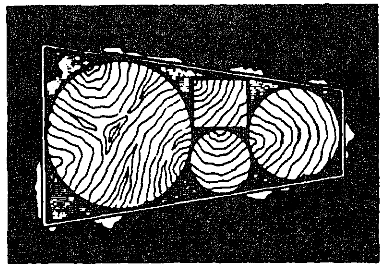


AREA OF HOLE = 19.65 SQUARE INCHES
AREA OF PLUG = 12.25 SQUARE INCHES
AREA OF LEAK = 7.40 SQUARE INCHES



DEPTH IN FEET	GALLONS PER MINUTE	PUMPS
1	319	3
2	451	4
3	552	
4	638	5
5	713	6
6	782	
7	844	
8	902	7
9	957	8

DEPTH IN FEET	GALLONS PER MINUTE	PUMPS
1	91	1
2	129	
3	158	
4	182	
5	204	
6	224	2
7	241	
8	258	
9	273	3



AREA OF HOLE = 21.0 SQUARE INCHES
AREA OF PLUGS = 15.0 SQUARE INCHES
AREA OF LEAK = 6.0 SQUARE INCHES

NOTES:
1. AVERAGE EFFECTIVE FLOODING AREAS SHOWN WITHIN WHITE LINES.
2. THESE FIGURES SHOW HOW IMPORTANT IT IS TO PUT SOME KIND OF PLUG INTO ANY HOLE RIGHT AWAY. ALL QUANTITIES ARE APPROXIMATE.

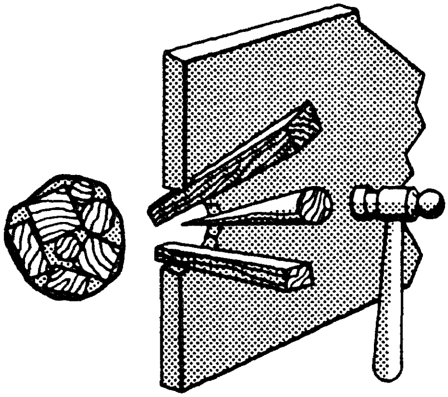
103.98

Figure 7-31.—Flooding effects comparing unplugged holes to partially plugged holes.

a better fit in the hole. One such combination of plugs is shown in figure 7-22.

It is usually best to wrap each plug with lightweight cloth before inserting it. The cloth tends to keep the plugs in place and fills in some of the gaps between the plugs. In most cases plugs will not make a watertight fit; but you can reduce the rate of leakage by using the plugs and then calking the remaining leaky areas with rags, oakum, and smaller wedges. In general, square-ended plugs hold better than conical plugs in holes in plating one-fourth inch or less in thickness.

Most wooden plugs are inserted from inside the ship. In such a case, repair personnel must contend with metal edges protruding inward.



17.7

Figure 7-22.—Combination of plugs used to plug a hole.

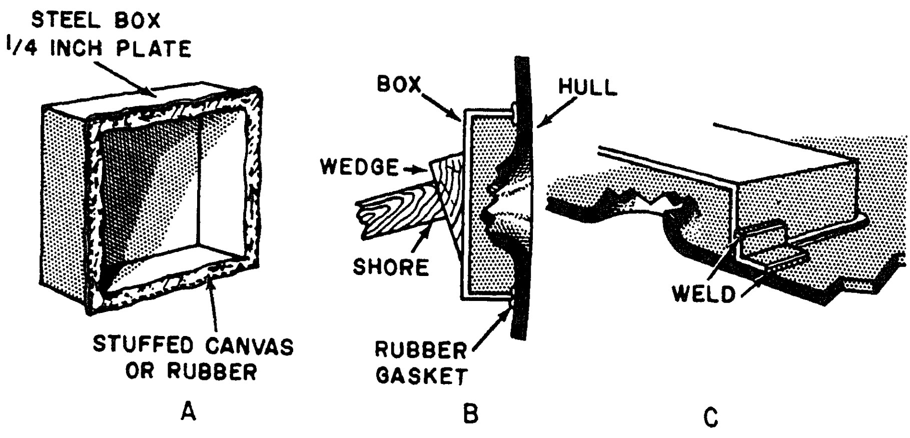
Plugs driven in from the outside do not usually present this problem. However, outside plugs cannot be tended readily and do not hold well over an extended period of time. If it is necessary to insert the plugs from the outside of the hull, rather than from inside, the inboard ends of the plugs should be fitted with screw eyes. A line from each screw eye made fast to a stanchion will help to keep the plug in place.

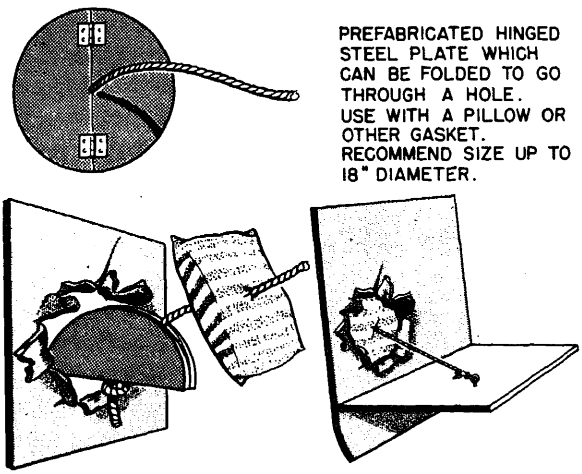
Patching

Box patches are effective for use over holes that have jagged edges projecting inboard. Part A of figure 7-23 shows a typical metal box patch; part B shows a metal box patch held in place by shoring; and part C shows a metal box patch welded in place over a hole that has jagged edges.

A hinged patch is designed for use over relatively small holes. This patch has no vertical support to hold it in place. Figure 7-24 shows a hinged plate patch before, during, and after installation.

A hookbolt is a long bolt, usually fabricated from round steel stock. Hookbolts come in various diameters and various shapes. The head is shaped so that the bolt can be hooked to plating through which the head has been inserted. Figure 7-25 shows T-, J-, and L-shaped hookbolts and shows how hookbolts are used to apply a patch. The long shanks are threaded and are provided





17.8.2

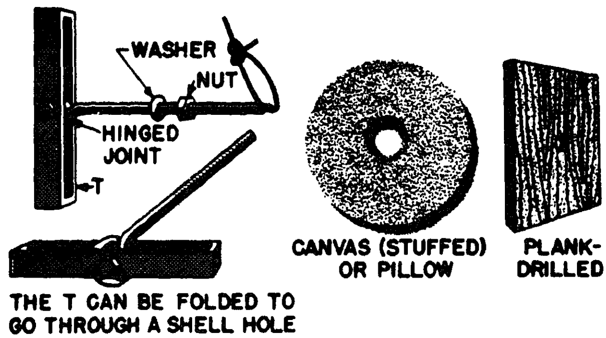
Figure 7-24.—Application of a hinged plate patch.

with nuts and washers. Wooden (or sometimes steel) strongbacks are used with hookbolts.

To use a hookbolt, insert the head end of the bolt through the hole and rotate or adjust the bolt until it cannot be pulled back through the hole. Slide a pad or gasket, backed by a plank or strongback, over the bolt and secure the patch by taking up on the nut. It is generally necessary to use these bolts in pairs. Hookbolts can be used with a variety of patches and in various combinations.

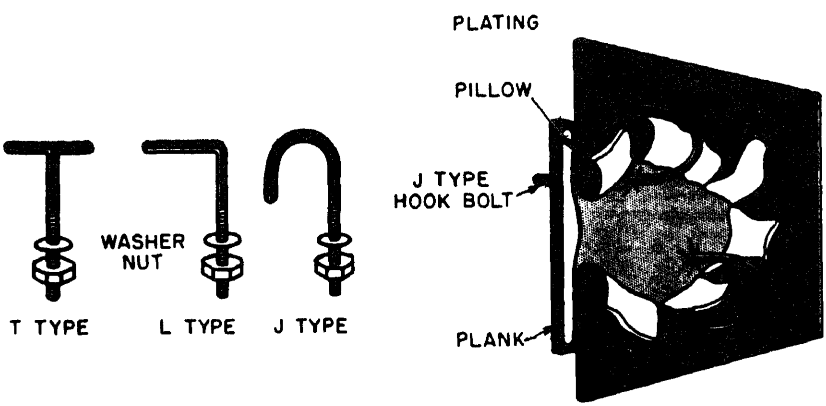
The folding T-shaped hookbolt resembles a T-shaped hookbolt, but has a hinge where the shank joins the crosspiece. This bolt can be folded and inserted through a small hole; when pulled back, the crosspiece catches on the hull plating. By using this bolt, a person standing inside the ship can put a patch on either the inside or the outside of the ship. By means of a retaining line on the bolt, a strongback and a pillow can be threaded over the line and the entire patch folded and tossed out through the hole. When the line is hauled in, the patch takes up against the ship. The patch can be readjusted to give a tighter fit. It is also possible to push the pillow and plate over the shank inside the ship, thus making an inside patch. Nuts and washers are provided for holding and tightening a patch; large wing nuts are often used.

Ordinary feather pillows have a tendency to ball up when they are wet, and they do not provide a uniform surface when used for patching holes. For this reason some ships carry special pillows (fig. 7-26) made of canvas and oakum.



17.8.4

Figure 7-26.—Materials used in assembling a folding T patch.



17.8.3

Figure 7-25.—Left: Types of hookbolts. Right: Use of hookbolts in applying a patch.

Figure 7-27 shows one way in which a folding T-shaped hookbolt can be used to secure a patch.

You will frequently find it necessary to improvise patches by using whatever material is handy. Improvising patches calls for skill and a certain amount of imagination. Hinged or folding prefabricated patches are usually the easiest to use and in many cases they are the most effective. But if they are not available, improvise patches.

CALKING JOINTS

A riveted joint is not inherently watertight or oiltight because the surfaces or edges that are held together are not machined or ground. Therefore riveted joints or boundaries tend to loosen from shock of gunfire, collision, vibration, explosion, and racking of the ship as a result of high-speed maneuvering. Repairs to this type of damage are usually made by calking the loosened joint. These repairs must be made as soon as defects are discovered.

In calking, a thin fin of metal is usually sprung from the base plate or structure by using a pneumatically driven chisel, calking tool, or hammer. The general procedure for calking a riveted joint is illustrated in figure 7-28.

SHORING

Shoring is often used aboard ship to support ruptured decks, to strengthen weakened bulkheads and decks, to build up temporary decks and bulkheads against the sea, to support hatches and doors, and to provide support for equipment that has broken loose.

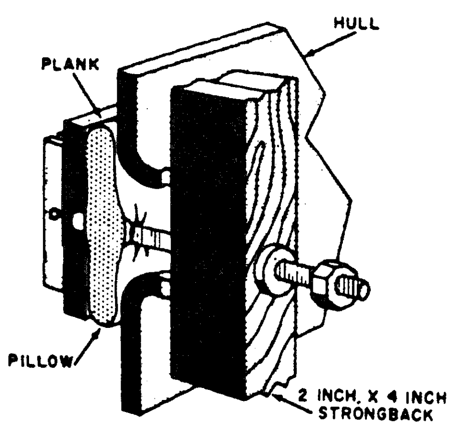


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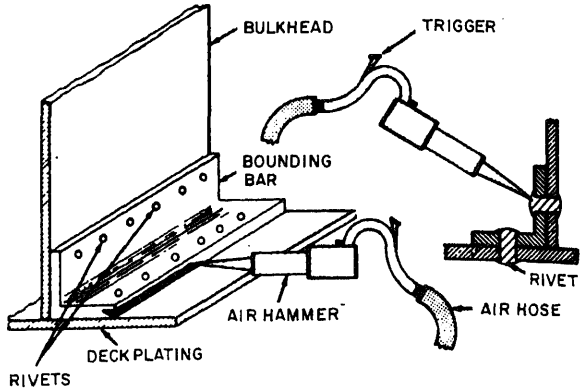
Figure 7-27.—One method of installing a folding T patch.



103.101

Figure 7-28.—Calking a riveted joint.

WHEN TO SHORE

When to shore is a problem that cannot be solved by the application of any one set of rules. Sometimes the need for shoring is obvious, as in the case of loose machinery or damaged hatches; but sometimes dangerously weakened supports under guns or machinery may not be so readily noticed. Although shoring is sometimes done when it is not really necessary, the best general rule to go by is this: In case of doubt, it is always best to shore.

SHORING MATERIALS

The basic materials required for shoring are shores, wedges, sholes, and strongbacks. A SHORE is a portable beam. A WEDGE is a block, triangular on the sides and rectangular on the butt end. A SHOLE is a flat block that may be placed under the end of a shore for the purpose of distributing pressure. A STRONGBACK is a bar or beam of wood or metal, often shorter than a shore, which is used to distribute pressure or to serve as an anchor for a patch.

Many other items of equipment are also used in connection with shoring. These include such things as wooden battens, claw hammers, mauls and sledges, handsaws, mattresses, pillows, axes, hatchets, wood clamps, chain falls, electric welding machines, oxyacetylene cutting outfits, cold chisels, wood chisels, nails, wooden plugs, packing sheets, turnbuckles, screwjacks, hydraulic

jacks, bolts, nuts, and washers. The allowance list indicates the quantity of such gear that each ship should carry on board.

Shores

The best woods available for shores are Douglas fir and yellow pine. Hemlock and spruce may be used, but they are not good because they are not as strong. The wood used for shores should be straight grained and relatively free of knots and cracks. Green timbers are not as strong as cured timbers; if it is necessary to use poor wood, more shores will have to be used than would be required for shores of better wood. Shores are treated with a fire-resisting chemical; they should NEVER be painted with ordinary paint.

In use, the length of a shore should never be more than 30 times its minimum thickness. Thus a shore that is 4 by 4 inches should not be longer than 10 feet; a shore that is 6 by 6 inches should not be longer than 15 feet; and a shore that is 4 by 6 inches should not be longer than 10 feet. The shorter the shore is in relation to its thickness, the greater the weight it will support. Shores should normally be carried aboard ship in 16-foot and 18-foot lengths that can be cut to the required lengths when needed.

Wedges

Wedges should be of soft wood, preferably fir or yellow pine. They should be cut with a coarse saw and left rough and unpainted; in this condition they will absorb water and hold better than if they are smoothed or painted. A few hardwood wedges should be kept on hand for special uses, since they have great resistance to crushing. However, hardwood wedges cannot be used for all shoring, since they have a tendency to work loose. When they are used, they must be checked frequently.

Wedges should be approximately as wide as the shores with which they are used. They may be made with various angles at the leading edge, but a blunt wedge will not hold as well as a sharp one. A wedge should be about six times as long as it is thick. Thus a wedge to be used with a shore that is 4 by 4 inches should be about 4 inches wide, 2 inches thick, and 12 inches long. Figure 7-29 illustrates some wedges and how they are used.

Sholes

Sholes should be made of Douglas fir or yellow pine planks 1 inch or more in thickness and from 8 to 12 inches wide. Wider sholes can be made by nailing cleats across two or more widths of planking. Even single planks may have to be cleated at the ends to keep them from splitting. It is neither necessary nor desirable to fabricate sholes in advance of the actual need for them; prefabricated sholes would probably not fit where they are needed. The use of a shole is illustrated in figure 7-30.

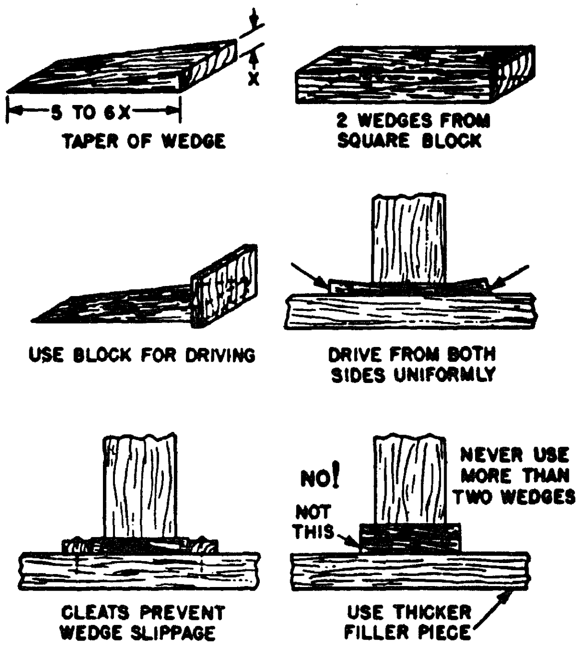


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Figure 7-29.—Wedges.

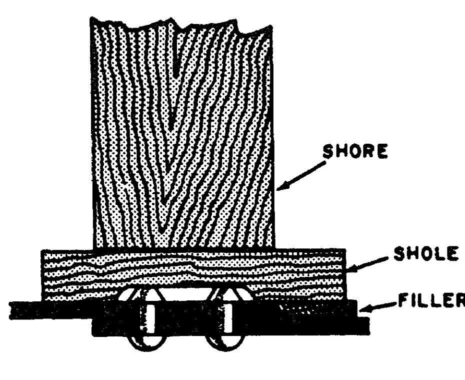

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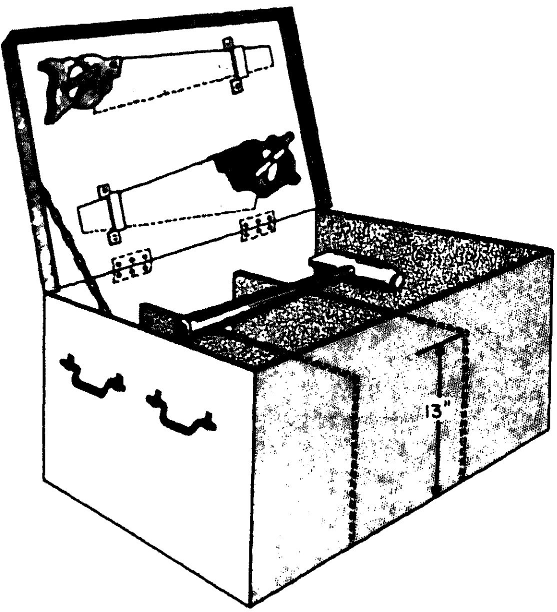
Figure 7-30.—Use of a shole.

Strongbacks

All or part of an ordinary shore may be used to make a strongback. Shoring scraps should be kept for use as strongbacks and short shores. Heavy planks, steel bars, angle irons, and pipe can also be used as strongbacks.

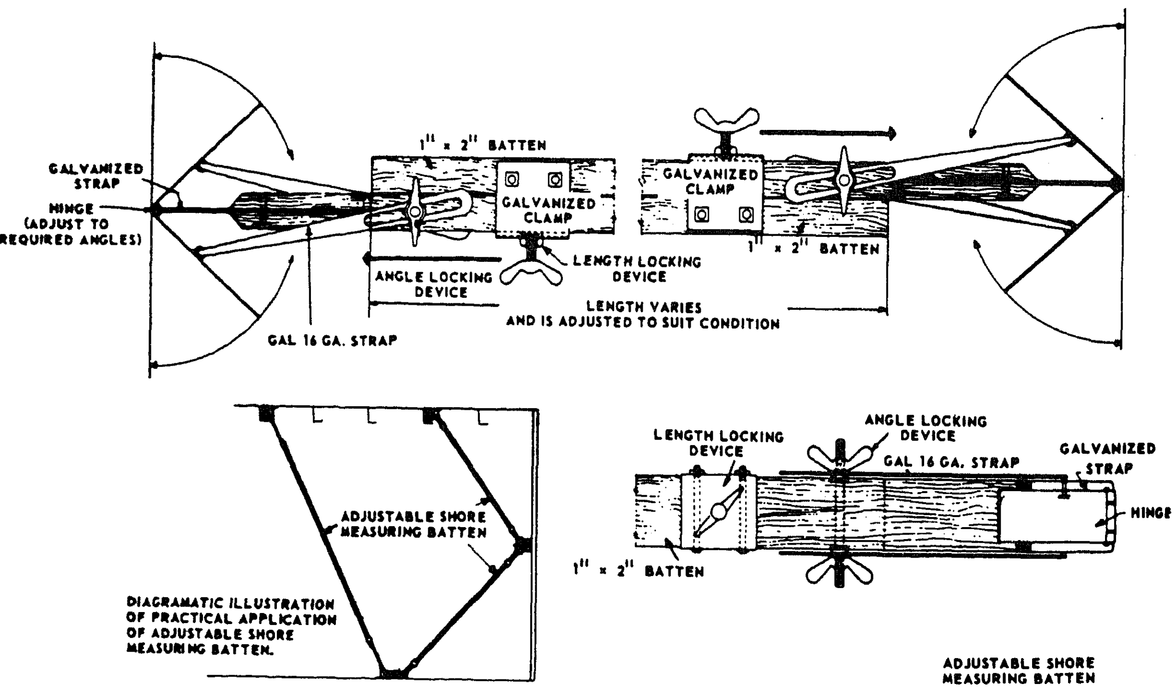


28.266
Figure 7-31.—Shoring chest.

Metal Shoring

Some metal shoring materials are used on some ships. A collapsible or telescopic metal shore consists of two sections of heavy-duty iron pipe, one sliding closely within the other. Holes are drilled every 3 or 4 inches along the outer pipe, and four holes are drilled along the inner pipe. Pins are provided so that the length of the shore can be adjusted and the sections can be held in place. A hinged shoe is often fitted to the end of the combined shore so that it can readily be fitted to any angle or inclination. The disadvantage of these metal shores is that they are not very rigid, and they are further weakened by the holes that must be drilled in them. Single lengths of pipe are stronger, and you can give them additional resistance to kinking and collapsing by filling them with sand.

Steel wedges are more valuable for prying things apart than for actual shoring. Steel wedges may be used in conjuction with wooden wedges to take some of the wear and pressure off of the wooden wedges. Steel wedges can



also be welded into place when you are making semipermanent repairs.

Steel sholes are better than wooden sholes for use under the ends of iron pipe that is being used as temporary stanchions. The pipe would cut through wooden sholes.

Although steel bars, angle irons, and pipe can be used for strongbacks, their tendency to spring back and forth under variable loads must be considered. These materials can also be used for making semipermanent repairs when time is available.

SHORING CHEST

A shoring chest (fig. 7-31) should be available at each below-deck repair station. The chest should be made of 16-gage steel. The dimensions of the chest are designed to suit the smallest opening through which the chest must be passed to reach damaged areas. The chest is NOT small enough to be passed through scuttles.

The shoring chest is divided into three compartments. Compartment A contains wedges. Compartment B contains two claw hammers, one hatchet, eight adjustable clamps, 5 pounds of oakum, a sounding rod or tape, a folding rule, a 100-foot steel tape, a spike maul, 15 pounds of nails (30d com.), 10 pounds of nails (20d com.), and an electric hand lantern. Compartment C contains 2- by 4- by 4-inch wooden blocks about 12 inches long. Carpenters' crosscut saws are attached to the lid of the box and a 10-pound sledge is stowed as shown in the illustration. If there is room, a 5 pound bag of sand should also be carried.

SHORING KIT

Shoring kits are much more portable than shoring chests, and they are also small enough to go through scuttles and other small openings. A shoring kit includes a carpenter's crosscut saw, a hatchet, a shoring batten, a sledge, a spike maul, assorted nails, eight precut wedges, and a claw hammer.

MEASURING AND CUTTING SHORES

The most rapid and accurate way to measure shores for cutting is by using an adjustable shoring batten similar to the one shown in figure 7-32. These battens can be made up from items carried aboard ship; one batten should be carried at each repair station.

To use the shoring batten, extend it to the required length and lock it with the thumbscrews on the length locking device. Then measure the angles of cut by adjusting the hinged metal pieces at the ends of the batten and lock the angle locking device in place. Lay the batten along the shore. Mark and cut the timber to the proper length and angle. In general, shores should be cut one-half inch shorter than the measured length to allow space for wedges.

If a shoring batten is not available, measure the shores for length by using a folding rule or a steel tape and a carpenter's square. The step-by-step procedure for measuring shores in this way, as shown in figure 7-33, is as follows:

1. Measure distance A from the center of the strongback to the deck. Then measure distance B from the edge of the anchorage to the bulkhead and subtract the thickness of the strongback.

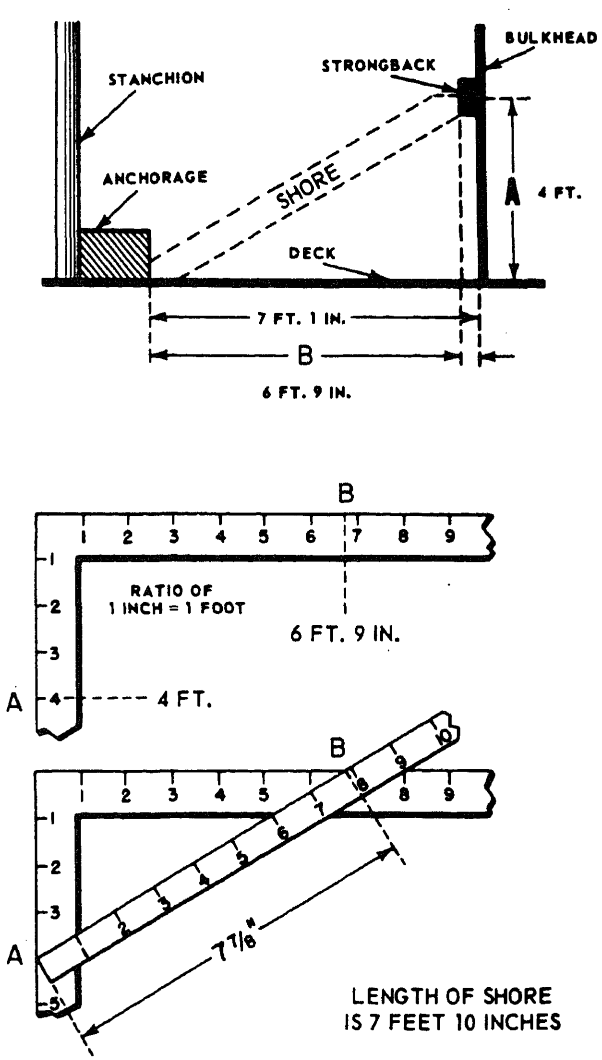


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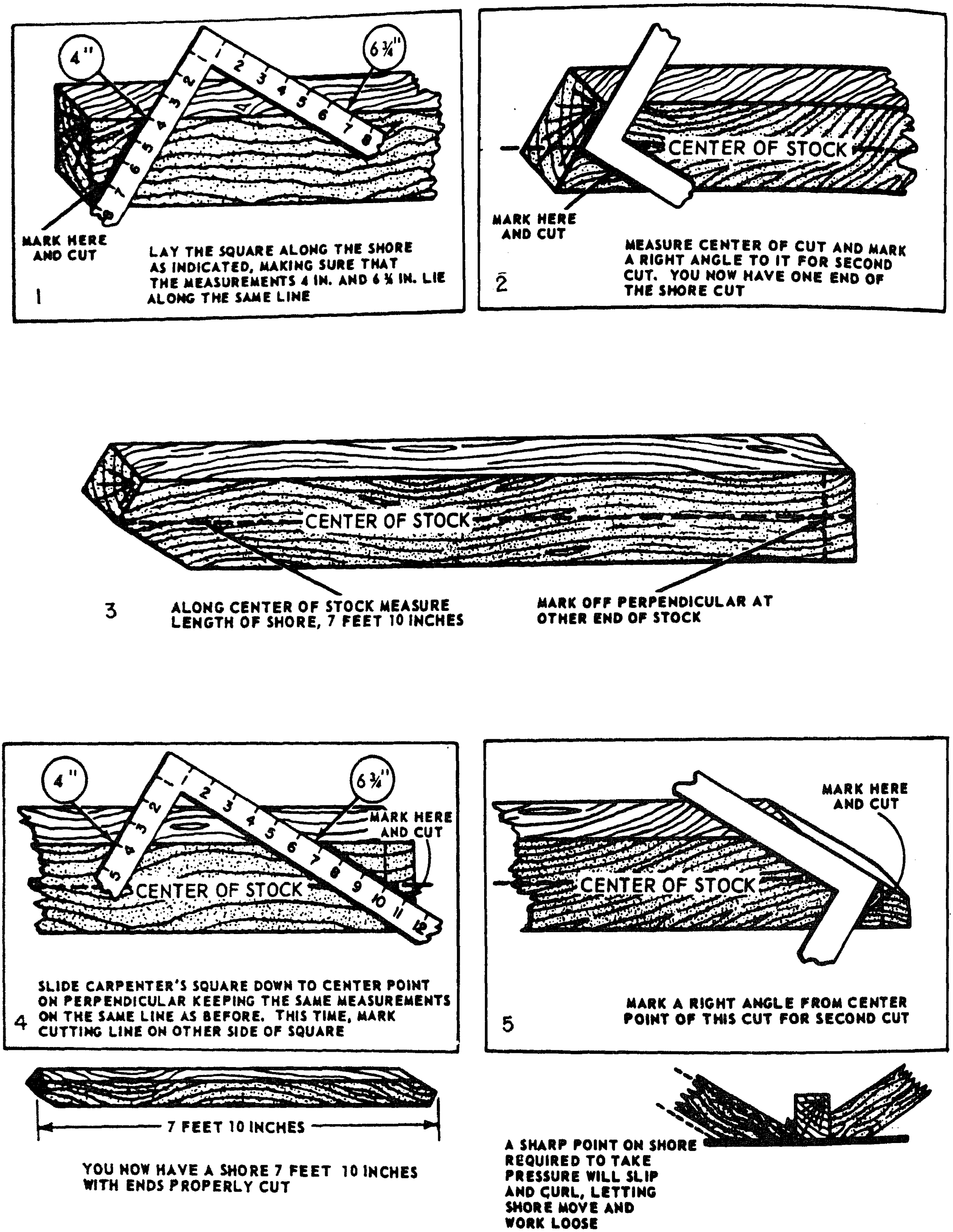
Figure 7-33.—Measuring length of shore.



103.106

Figure 7-34.—Cutting the angles of a shore.

2. Lay off the measurements of distances A and B on a carpenter's square, using the ratio of 1 inch to 1 foot. Rule measurement is taken to the nearest one-sixteenth of an inch. To maintain the 1-inch-to-1-foot ratio, use the following conversion table:

ACTUAL RULE MEASUREMENT	MEASUREMENT ON CARPENTER'S SQUARE
3/4 inch	1/16 inch
1 1/2 inches	1/8 inch
2 1/4 inches	3/16 inch
3 inches	1/4 inch
3 3/4 inches	5/16 inch
4 1/2 inches	3/8 inch
5 1/4 inches	7/16 inch
6 inches	1/2 inch
6 3/4 inches	9/16 inch
7 1/2 inches	5/8 inch
8 1/4 inches	11/16 inch
9 inches	3/4 inch
9 3/4 inches	13/16 inch
10 1/2 inches	7/8 inch
11 1/4 inches	15/16 inch
12 inches	1 inch

3. Measure the diagonal distance between A and B. In the example given in figure 7-33, this distance is 7 7/8 inches. Because of the 1-inch-to-1-foot ratio, the distance in feet would be 7 7/8 feet or 7 feet 10 1/2 inches.

4. Subtract one-half inch, since shores should be cut one-half inch shorter than the measured distance. Thus the final length of the shore should be 7 feet 10 inches.

The carpenter's square may also be used to measure the angles of cut and to mark the shore for cutting, as illustrated in figure 7-34. Using the same measurements as in the previous example, proceed as follows:

1. Lay the square along the shore as shown in part 1 of figure 7-34, making sure that the measurements 4 inches and 6 3/4 inches lie along the same line. Cut the shore to this line.

2. Measure the center of the cut and mark a right angle to it for the second cut. Mark and saw to the line. You have now completed cutting one end of the shore.

3. Along the center of the timber, measure the length of the shore (7 feet 10 inches) and mark off a perpendicular line at the other end of the shore.

4. Slide the carpenter's square down to the other point on the perpendicular, keeping the same measurements on the same line as before. This time, mark the cutting line on the other side of the square.

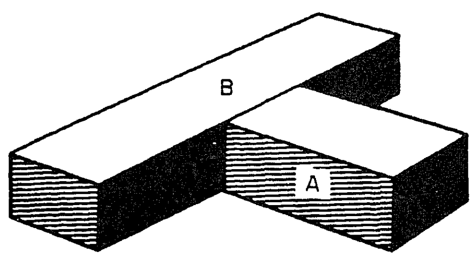
5. Mark a right angle from the center point of this cut for the second cut. Make your cuts, and you will have a shore 7 feet 10 inches long with the ends properly cut to fit the measurements.

The proper cutting of shores is an important part of any shoring operation. Shores are usually cut with a hand-held circular saw; however, an ordinary carpenter's handsaw may be used. All repair party personnel should be instructed in the correct use of these tools. Poorly cut shores may cause delay in completing the shoring job and may cause failure of the shoring because the wedges and shores will not fit properly if the shores are not cut correctly. Wet timbers are particularly hard to cut unless the proper methods of sawing are used. In cutting heavy shores, a lumberjack crosscut saw will save a good deal of time. Chisels, axes, and hatchets are also used for cutting shores.

TRIMMING SHORES

Shores must be trimmed to fit the shoring structure, and the trimming must be done to prevent splitting or chipping of the shores. If shore A in figure 7-35 is to fit against a plane surface of shore B, and if it must take a load in compression, the end of shore A must be cut square and perpendicular to the long axis of shore A.

A sharp point must never be used when a shore will be required to withstand pressure. A pointed end will slip and curl and allow the shore to work



80.205

Figure 7-35.—Trimming shore to shore.

loose and move. Figure 7-36 shows correct and incorrect ways to trim shores to present a flat surface at each pressure area.

Shores are sometimes notched at the end to fit against other shores. However, this method should not be used if any great pressure is to be expected. A safer method is to cut a socket in the side of one shore and fit the butt of the other shore into the socket. This method is illustrated in figure 7-37.

SHORING PRINCIPLES

Most shoring is done to support bulkheads that are endangered by structural damage or weakness caused by a hit or by the pressure of flooding water. The pressure on the bulkhead of a flooded compartment is tremendous, and expert shoring is required to hold such a bulkhead in place. Some of the general rules to remember in connection with shoring bulkheads are as follows:

1. Always allow a large margin of safety. Use MORE shores than you think you need rather than fewer.

2. Spread the pressure. Make full use of strength members by anchoring shores against beams, stringers, frames, stiffeners, stanchions, barbettes, and so forth. Place the legs of shoring against the strongback at an angle or 45° or 90°, if at all possible. Figure 7-38 illustrates the

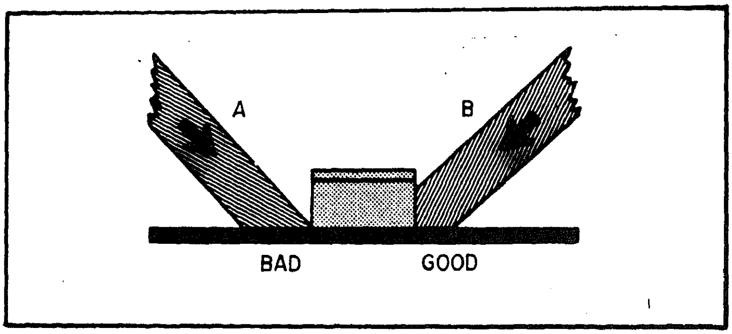


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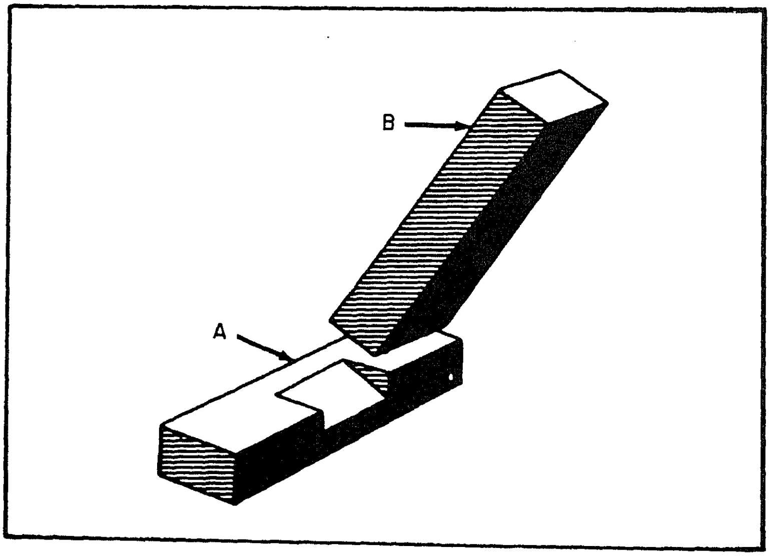
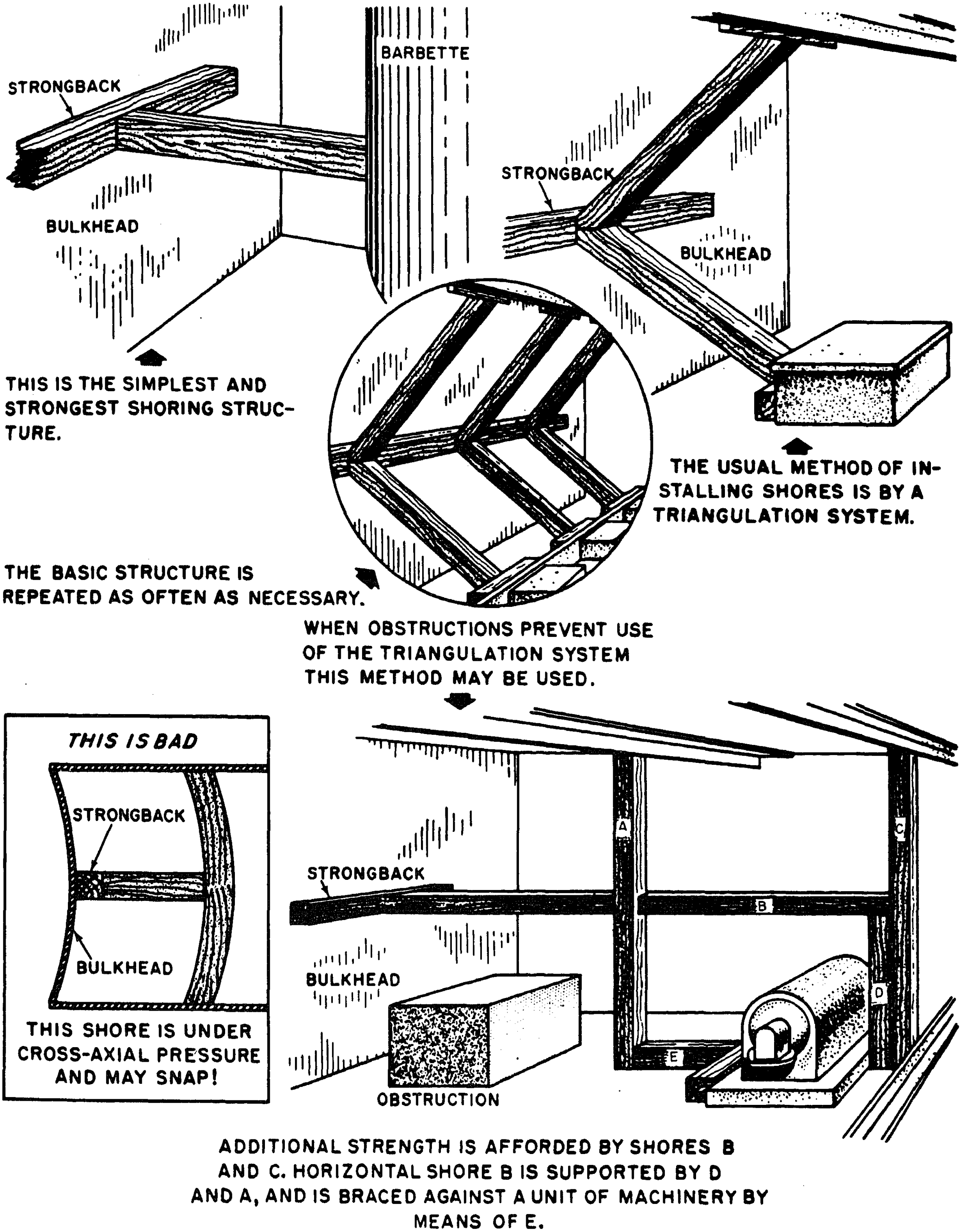
Figure 7-36.—Trimming shore to deck.



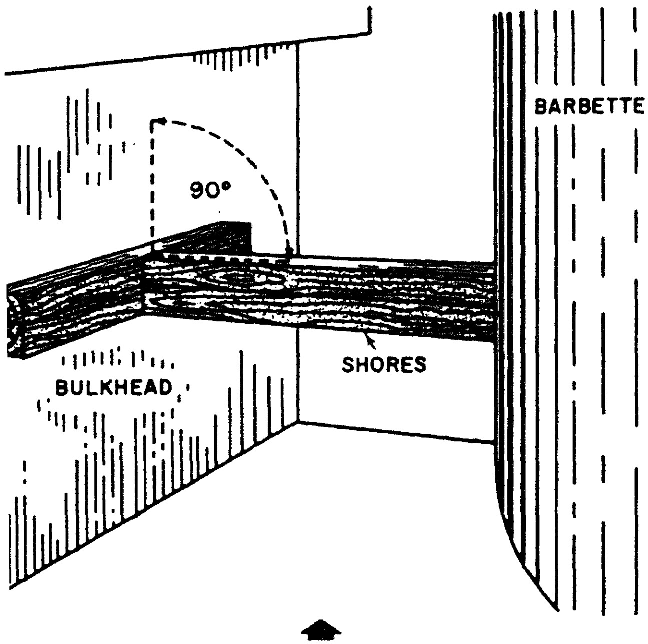

BARBETTE
STRONGBACK
BULKHEAD
THIS IS THE SIMPLEST AND STRONGEST SHORING STRUCTURE.
STRONGBACK
BULKHEAD
THE USUAL METHOD OF INSTALLING SHORES IS BY A TRIANGULATION SYSTEM.
THE BASIC STRUCTURE IS REPEATED AS OFTEN AS NECESSARY.
WHEN OBSTRUCTIONS PREVENT USE OF THE TRIANGULATION SYSTEM THIS METHOD MAY BE USED.
THIS IS BAD
STRONGBACK
BULKHEAD
THIS SHORE IS UNDER CROSS-AXIAL PRESSURE AND MAY SNAP!
A
C
STRONGBACK
B
BULKHEAD
D
E
OBSTRUCTION
ADDITIONAL STRENGTH IS AFFORDED BY SHORES B AND C. HORIZONTAL SHORE B IS SUPPORTED BY D AND A, AND IS BRACED AGAINST A UNIT OF MACHINERY BY MEANS OF E.

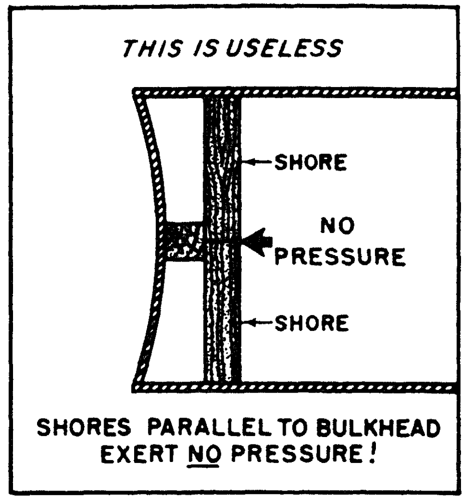
simplest and strongest shoring structure; figure 39 shows shoring angles.

3. Do not attempt to force a warped, sprung, bulged bulkhead back into place. Place the shoring so that it will hold the bulkhead in its warped or bulging position.

4. When possible, strengthen the main shores with auxillary shores.

SHORES MUST FORM A CONSIDERABLE ANGLE WITH THE BULKHEAD THEY ARE SUPPORTING.

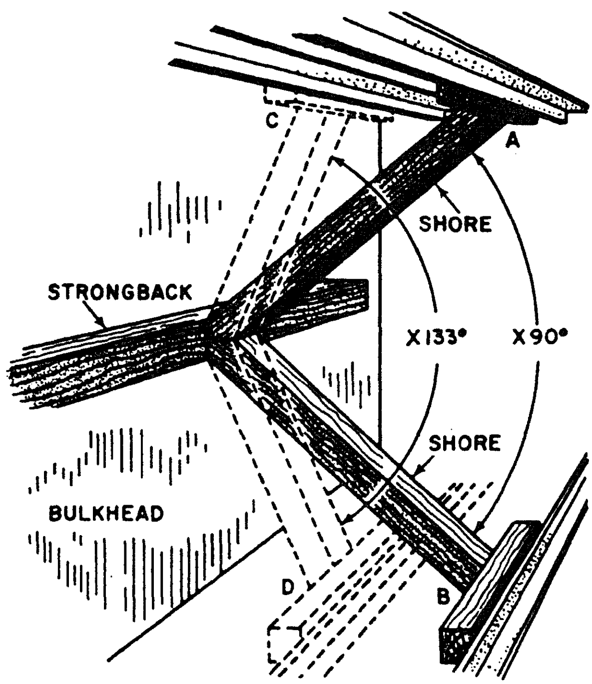




1 SHORES PERPENDICULAR TO BULKHEAD EXERT MAXIMUM PRESSURE.

2 WHEN THE ANGLE OF THE 2 SHORES (X) IS GREATER THAN 90°, THE EFFECTIVENESS OF THE SHORES IS LESSENED.

3 THEREFORE IT IS BETTER TO ANCHOR SHORES AT A AND B THAN AT C AND D.



The same general principles apply to shoring a hatch or door; but the entire hatch or door should be shored and the pressure should be spread over both the hatch cover or door and the supporting structure, as shown in figure 7-40. Remember that hatches and doors are the weakest part of the bulkhead or deck in which they are installed. Shoring doors and hatches may be complicated by the presence of scuttles and quick-acting handwheels; in such cases it will be necessary to arrange the shores to clear the wheel. A basic rule is to put as many points of pressure on the closure as there are dogs on the closure.

The success of any shoring job depends in a large part on the way in which the timbers are wedged. As the shoring job progresses, check carefully to see that all wedges are exerting about the same amount of pressure on the member being shored. Use as few wedges as possible to obtain satisfactory results. Always drive wedges uniformly from both sides so that the shore end will not be forced out of position. Lock the wedges in place so that they will not work loose and cause the shoring to slip. Figure 7-41 shows how to lock wedges in place.

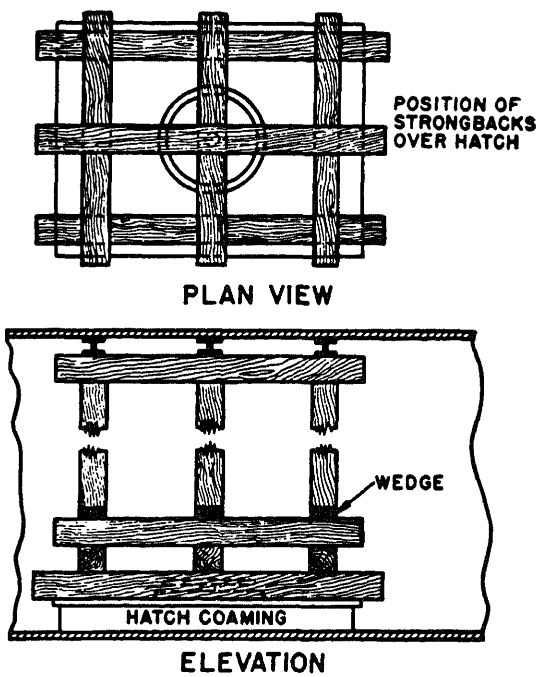


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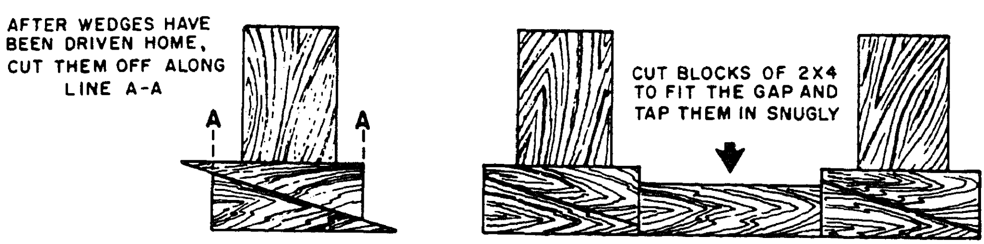
Figure 7-40.—Shoring a hatch.

PRACTICE SHORING

If you are in charge of a shoring detail, and if you have enough shores on board, it is a good idea to give your personnel some practice in shoring. As they put up shoring, explain what they are doing right and what they are doing wrong and, in each case, why it is right or wrong. See that they grasp the principles of spreading the pressure, and see that they understand why a shore in cross-axial pressure might snap. Be sure that the personnel learn how to measure shores before cutting them and how to cut them correctly.

If possible, obtain permission to put shoring up in a compartment where it may be left for a few days so that other crew members may inspect it and indirectly learn something about how to shore.

When doing practice shoring jobs, be careful to see that shores are not cut more than necessary. You will seldom have an oversupply of shores aboard ship. If you do not have spare shores for practice jobs, use strips and battens to build mockups and models to scale. Although models are not as effective for training as actual practice shoring jobs, they do have some training effect. One advantage of models is that you can work out some rather elaborate shoring problems with them. Also, the models can be kept and used again and again for training purposes.



28.271

Figure 7-41.—Locking wedges in place.

After shoring practice has been completed (either using a model or full size shores), it is a good idea to have personnel discuss the job and make comments on the good and bad points of the shoring. Some of the questions to be brought up in this discussion include the following: Is the shoring job effective? Could it be made just as effective with fewer shores? Should more shores have been used? Is the shoring pressure correctly spread? Is the wedging done correctly? This type of questioning and discussion can be very effective as a device for making sure that personnel really understand the problems and principles of shoring.

CASUALTY POWER SYSTEMS

The casualty power system is one of the most important damage control systems. The system is a simple electrical distribution system that is used to maintain a source of electrical supply for the most vital machinery and equipment needed to keep the ship afloat or to get the ship out of a danger area. The casualty power system is intended to provide power during real emergencies only; it must NOT be used as a means of making temporary routine repairs.

A casualty power system consists of portable cable stowed in racks thoughout the ship, bulkhead terminals for carrying the circuit through bulkheads without breaking the watertight integrity of the ship, risers between decks, and casualty power connections at the source of supply. Figure 7-42 illustrates a casualty power run.

Portable casualty power cables are equipped with metal tags that indicate the length of the cable and the location of the cable stowage rack, as shown in figure 7-43. Portable casualty power

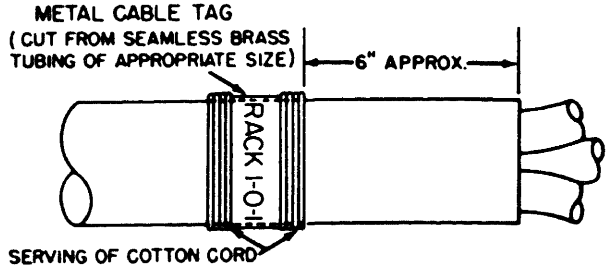


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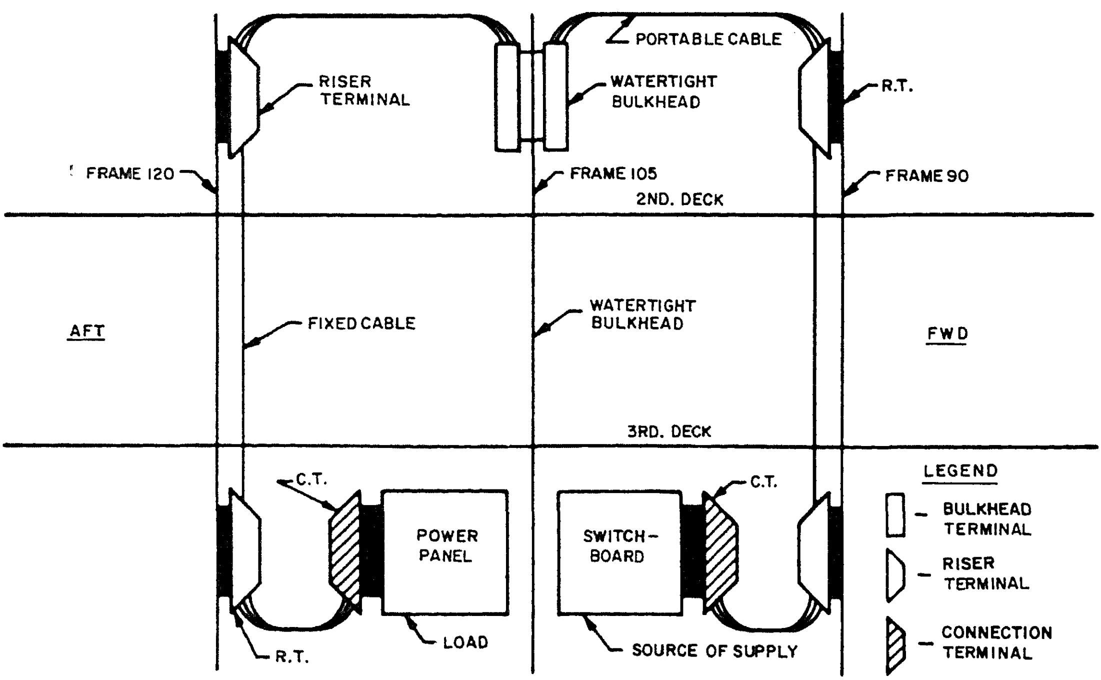
Figure 7-43.—Portable casualty power cable tag.



103.140

Figure 7-42.—Casualty power run.

cables should be rigged only when required for use or when required for practice in rigging the casualty power system. At all other times, the cables should be stowed in the cable rack indicated on the cable tag.

When casualty power cables are rigged, the connections must always be made from the load to the supply to avoid handling energized cables. Portable signs saying DANGER—HIGH VOLTAGE must be posted at each connection and at 10-foot intervals along the length of the cable. Cables must be secured to the overhead, clear of the deck.

Sources of supply for casualty power use are provided at each ship's service and emergency switchboard. These consist of casualty power connection terminals on each switchboard, the terminals being connected to the bus bars through circuit breakers. Some ships also have small diesel-driven generators designated for casualty power use only; these are quite small and have very little control equipment.

Casualty power connection terminals are installed in power panels that feed equipment designed to receive casualty power. The casualty power connection terminals on the power panels may also be used as a source of supply to the casualty power system.

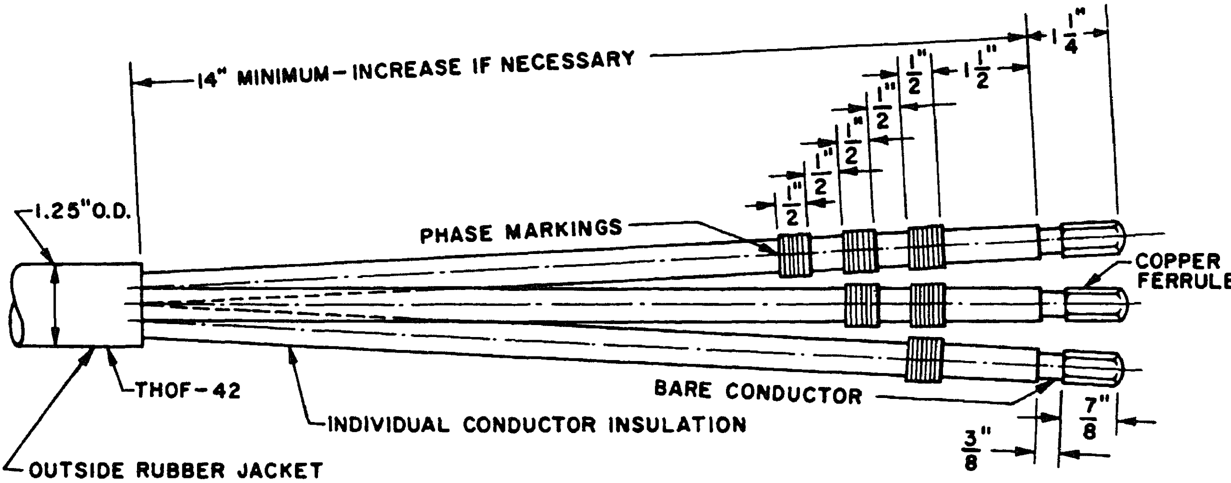
Remember that all terminals on power panels are HOT. The normal supply to a panel must be shut off before the casualty power cable is connected to the terminals.

Machinery that can be supplied by the casualty power system includes steering gear, IC switchboards, fire pumps, and vital auxiliaries in firerooms and engine rooms.

An ac casualty power system consists of the following equipment and fixtures.

1. Racks containing various lengths of portable thermoplastic-covered or neoprene-covered cable. Each cable contains three leads or conductors, as shown in figure 7-44. One lead is colored black, one is white, and one is red. This same color code is used in all three-wire power circuits throughout the electrical installations aboard ship.

2. On small ships, bulkhead terminals provide for a single horizontal run or portable cable along the main deck, inside the superstructure. On large ships, there are generally terminals for two horizontal runs, one port and one starboard; these are located on the second deck. The terminals extend through the bulkhead and project from it on both sides; they do not impair the watertight integrity of the ship. The cable ends are inserted into the holes provided around the outer rim (or curved surface) of the terminal. There are three groups of three holes each. The face of the terminal also contains three groups of three holes each, into which fit the square-shanked insulated wrenches that are used to secure the cable in the terminal. Two of these wrenches are provided in a rack mounted on the bulkhead at each point where they are required. They must be kept in the rack at all times except when they are actually in use.



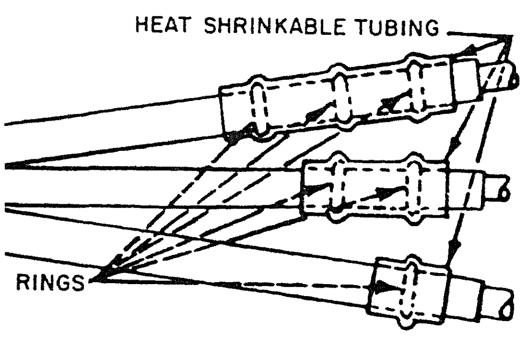
70.6

3. Riser terminals are similar to bulkhead ninals except that they are connected to other r terminals by permanently installed armored le to provide vertical runs. These riser ninals carry the casualty power from the erators to the main second deck levels.

4. Portable switches are sometimes mounted bulkheads near the cable racks. These are ply ON-OFF switches that are equipped with cial holes for use with the portable cables.

The faces of the casualty power terminals of ac system are marked A, B, and C; and the s of the cables are colored black, white, and , respectively. When connecting the cables to terminals, connect the black lead to A, the te lead to B, and the red lead to C.

The color code is not sufficient for making per connections in darkness or under other erse conditions. Therefore, it is necessary to vide some means of identifying each lead and roper hole in the terminal by touch when there ot enough light for visual identification. This ccomplished by molded knobs in the A, B, and ortions of the terminals. There are one, two, hree knobs, respectively, in the A, B, and C tions of the terminals. Similarly, a piece of vy twine is placed on the black lead of the able cables, two pieces are placed on the white l, and three pieces are placed on the red lead. h of these servings of twine is about half an i wide. (A new method of phase identification milar to the old method, except that O rings heat shrinkable tubing have been substituted the cotton cord servings, as shown in figure 5.) You can identify each lead and its responding position in the terminal by merely ing the leads and matching the number of es of twine on each lead with the same number



70.6

igure 7-45.—New method of cable identification.

of raised knobs in the proper area of the terminal. In older ships, the casualty power fittings have identifying V-shaped notches in the outer edge of the fittings instead of the knobs.

When you are connecting casualty power cable runs, remember that you must ALWAYS connect from the load to the source of supply to avoid working with live cables.

NUCLEAR WARFARE

On July 16, 1945, the first atomic bomb was exploded in the desert near Alamogordo, New Mexico. The first military use of a nuclear weapon took place only a few weeks later when an atomic bomb was dropped on the Japanese city of Hiroshima. The nuclear warfare era had begun.

Since that time the use of nuclear weapons has been incorporated into almost every type of warfare, including war at sea. All of the world's largest seapowers have the capability to use nuclear weapons against targets at sea. Merchant marine officers should understand the nature of nuclear weapons and shipboard defensive actions that can be taken to lessen their effect.

Over the years the yield of nuclear weapons has increased significantly. Despite this, the basic physical principles underlying the release of nuclear energy remain unchanged. For this reason, let us move on to a discussion of the basic physics of the atom and nuclear bursts.

BASIC SCIENCE OF THE ATOM

All substances consist of one or more of about 100 different kinds of simple material known as elements. Among the common elements are the gases hydrogen, oxygen, and nitrogen; the solid nonmetals carbon, sulfur, and phosphorus; and various metals, such as iron, copper, and zinc. A less familiar element, which has attained prominence in recent years because of its use as a source of atomic or nuclear energy, is uranium, normally a solid metal.

The smallest unit of an element that retains the characteristics of that element is the atom. Atoms are composed of even smaller particles called electrons, protons, and neutrons; and the characteristics of an element are determined by the relative numbers of these subatomic particles present in its atoms.

The electron is extremely tiny, being about 1/1840 the mass of a proton. The electron has a negative electrical charge; the proton has a positive electrical charge. A neutron, about the

same mass as a proton, is composed of a proton and an electron. It has no charge, because the equal and opposite charges of the electron and proton cancel each other.

The structure of an atom resembles a solar system with the protons and neutrons clustered tightly in the center, called the nucleus, and the electrons orbiting the nucleus (fig. 7-46). Because the distance between the electrons and the nucleus is so great compared to the size of the particles, an atom is mostly empty space. The number of electrons orbiting a nucleus in a normal atom is equal to the number of protons in the nucleus; thus the electrical charge of an atom is balanced. Neutrons in a nucleus can vary from 0 to more than 150. If an electron is removed from its orbit, the atom will have a positive charge. Likewise, if an electron is added to an atom, it will then have a negative charge. Such charged atoms or groups of atoms are called ions. We will learn later how ions are used in instruments for detecting nuclear radiation.

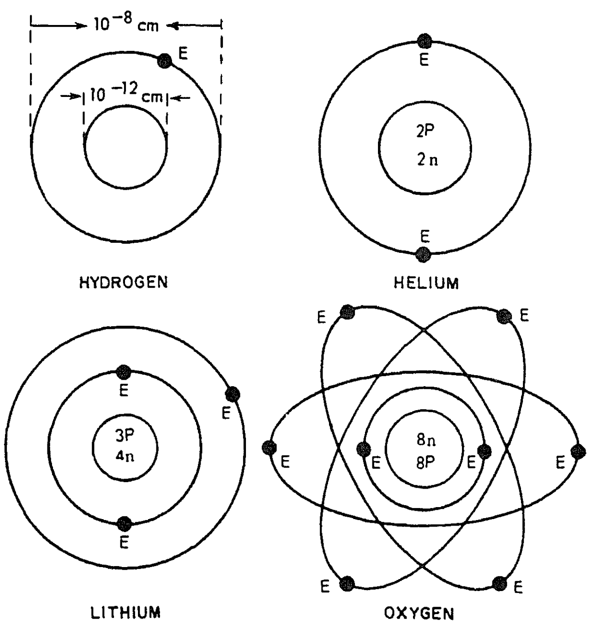
The number of protons in an atom determines which element it is. Hydrogen atoms, for example, contain only 1 proton; helium atoms have 2; uranium atoms have 92; and plutonium atoms have 94 protons. The number of protons in the nucleus of an atom is the atomic number of the atom (element).

Each element also has a mass number, which is the sum of the protons and neutrons in the nucleus of each of its atoms. Because the number of neutrons in an atom of any given element is not always the same, different atoms of the same element can have different mass numbers. Atoms of an element having different mass numbers are called isotopes of one another. They often are designated by the name of the element, followed by the mass number of the specific isotope. Thus, uranium (92 protons) with 146 neutrons is uranium 238. Uranium with 143 neutrons is uranium 235.

Nature's simplest element, hydrogen, has 1 proton and no neutrons; but hydrogen also has two other isotopes, deuterium with 1 neutron and tritium with 2 neutrons. Figure 7-47 illustrates the three isotopes of hydrogen and the method of assigning symbols to elements and isotopes. In this instance, H stands for hydrogen, the subscript ($_1H$) shows the atomic number of the element, and the superscript ($_1H^2$) shows the atomic mass of the isotope being considered. All but about 20 of the elements occur in nature in two or more isotopic forms; and many other isotopes, which are unstable (radioactive), have been obtained in various ways.

Although the ratio of neutrons to protons in the nucleus can vary, there seems to be a limit on the proportion required in a stable (nonradioactive) nucleus. In the lighter elements, nearly equal numbers of neutrons and protons are required for stability. As the weights of the elements increase, the proportion of neutrons required for stability also increases.

Protons in the nucleus of an atom have like (positive) charges and therefore repel each other. The neutrons reduce this force of repulsion and act as a binder to hold the nucleus together; otherwise, the force of repulsion would blow the nucleus apart instantly. Another force



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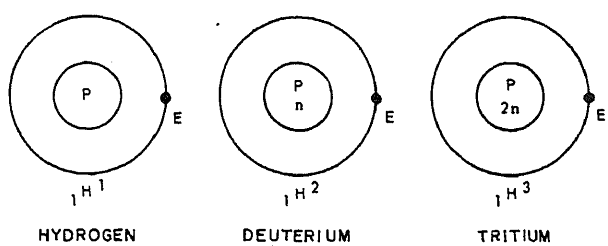

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also acting between the protons. This force ds to draw the protons together when they ne extremely close to each other, much like two ›ps of oil merge when they are placed in close ›ximity. Thus, in a stable nucleus the force of ulsion is less than the force of attraction or nesion.

In light elements, the force holding a given cleus together is greater than the force that ds to push it apart. This condition is not true certain heavy elements. In the nucleus of a en uranium atom, for example, the repulsion ween the particles may exceed the attraction. us, the uranium nucleus is unstable and some he particles are ejected. This disintegration of nuclei of atoms is called radioactivity or ioactive decay.

Nuclear radiation can be either in the form of ctromagnetic radiation (gamma rays) or ticles (alpha, beta, or neutrons) ejected from nuclei of atoms.

Gamma rays are energy, much like light rays, are indistinguishable from X-rays. Neutrons, explained previously, are electrically neutral ticles from the nuclei of atoms. Alpha particles identical to the nucleus of a helium atom. They emitted from the nucleus of an atom and are nposed of 2 protons and 2 neutrons. Beta par-es are high-speed electrons that also have been cted from the nucleus of an atom. This ement may sound confusing, because there are electrons in the nucleus. The paradox is lained by the fact that a neutron can break vn into a proton and an electron. When this t happens, the electron is ejected from the leus and the proton is left behind.

SION AND FUSION

Modern scientists also have been intrigued by idea of transforming one element into another, over 50 years ago began experimenting. They w that a change must be effected in the nucleus that such a change could be made by (1) easing the atomic number and mass number adding particles to the nucleus or (2) de-sing those numbers by removing particles n the nucleus.

With such thoughts in mind, the physicists an bombarding various nuclei with alpha icles, electrons, and gamma rays. At last one eriment was successful. In 1919, Lord Ruther-l found that he could produce oxygen by bom-ling nitrogen with fast-moving alpha particles. se particles entered the interiors of the nitrogen ei and protons were expelled. The first man-e nuclear reaction had been achieved.

Following this important discovery, other physicists bombarded other elements with various nuclear particles, including protons and neutrons. As man gained proficiency in performing nuclear transformations, he observed that the total weight of the end products of a nuclear transformation was not always the same as the weight of the original reactants. No matter how carefully the work was done, there always seemed to be a weight or mass difference between the input and the output. The only reasonable explanation was that a certain amount of material was lost or destroyed in the reaction. For a time this loss was accepted and simply regarded as a lost weight or mass difference. But this conclusion was contrary to a fundamental law of physics that neither matter nor energy can be created or destroyed.

Einstein explained this dilemma by proving that the mass difference in a nuclear reaction was converted into an equal quantity of energy. Einstein's theory stated: "The sum of matter and energy in a particular system is constant, but matter and energy are mutually interconvertible." In other words, when a certain amount of mass disappears in a nuclear reaction, an equivalent amount of energy will appear.

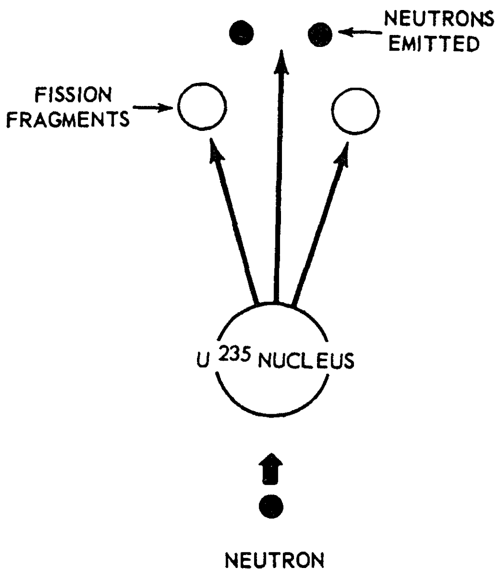
Further, Einstein showed that a simple relationship existed between mass and energy. This relationship is expressed as follows: $E = (m)\,c^2$, in which

E = energy in ergs liberated
m = lost weight or mass in grams of matter which disappears
c = velocity of light in centimeters per second

Application of Einstein's formula soon disclosed the tremendous energy release possible if the atom could be unlocked. It was calculated that certain nuclear reactions could produce energy releases several million times greater than chemical reactions. When lithium is bombarded by protons, for example, helium is formed and the resulting mass difference is transformed into energy. If one pound of lithium were fully used in a nuclear reaction, the resulting energy release would be equivalent to that obtained by burning 7 million tons of coal.

Fission

Fission may be defined as the process in which the nucleus of a heavy element is split into nuclei of lighter elements. Before 1938, thousands of nuclear reactions were acheived, but little serious consideration could be given to them as a practical source of energy. In the first place, huge

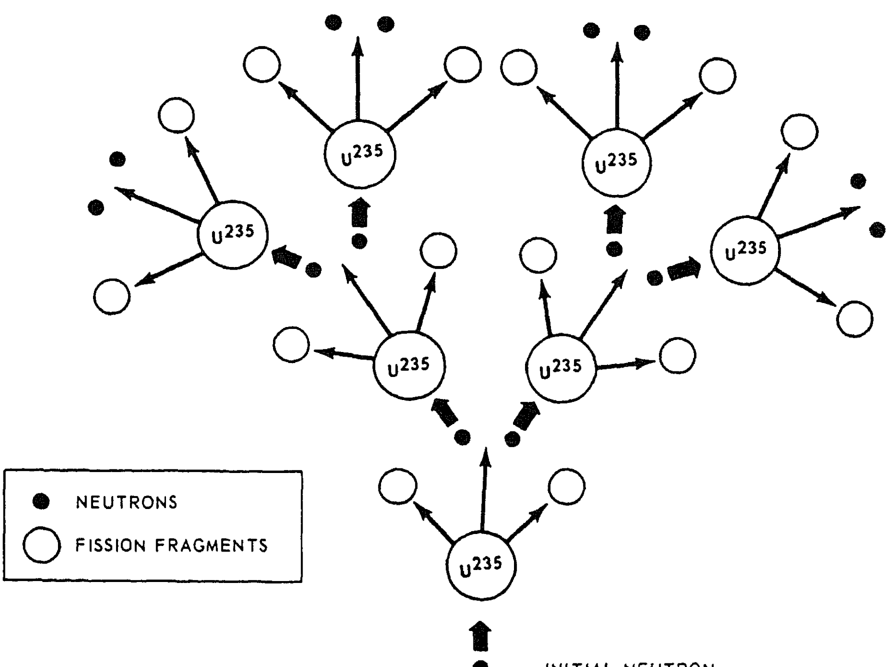


100.25
Figure 7-48.—The fission of uranium (U-235) by a neuton.

amounts of energy were required to initiate the nuclear reaction. Second, in those reactions in which more energy was released than used in starting the reaction, it seemed impossible to keep the reaction moving. Unless the reaction could be kept moving—that is, a chain reaction—there could be little use for the technique of splitting the atom. To produce a self-sustaining or chain reaction, the fission of one atom must produce the fission of another atom, and so on without stopping.

In 1938, however, Hahn and Strassmann (German scientists) achieved the fission of uranium into two nearly equal parts by bombarding the nucleus with neutrons. As depicted in figure 7-48, the fission of uranium 235 is accompanied by the formation of fission products and, most important of all, by simultaneous release of two or more neutrons.

These released neutrons then are free to cause the fission of other uranium 235 atoms; thus, a chain reaction using uranium 235 is possible. A simple chain reaction, where the fission of one atom produces the fission of only one other atom, and so on, will supply a constant source of energy; that is, the energy into which the mass difference is transformed during each fission. Because uranium 235 produces at least two neutrons with each fission, it is possible for each fission to cause two or more fissions as the next step in the chain. Such a reaction, the first three steps of which are shown in figure 7-49, is called a multiplying chain reaction. If each step of this reaction were to work perfectly—that is, every neutron produced at each step caused a fission in the next step—an extremely rapid reaction liberating tremendous energy would take place. (The man-made plutonium also produces this multiplying chain reaction.)



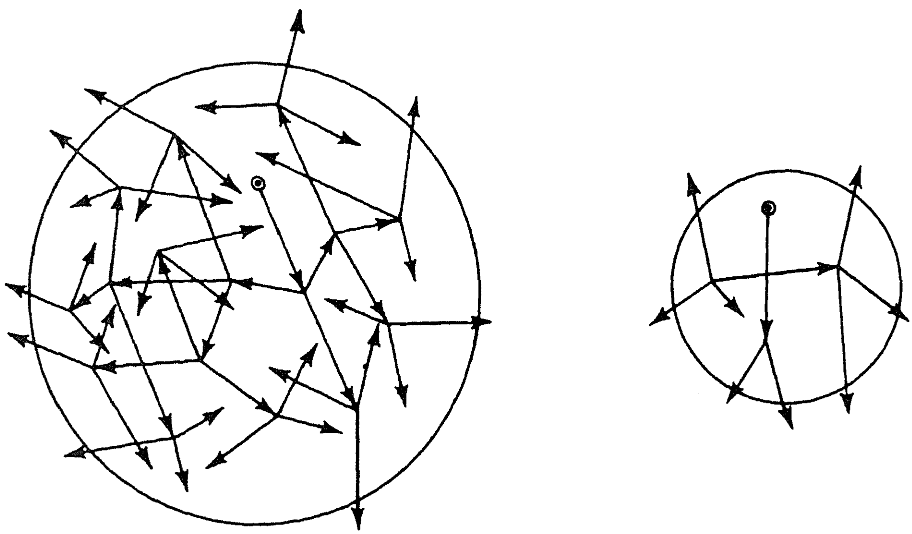
Experiments proved that the fission of ıranium would release 10 to 100 times the energy eleased in other nuclear reactions. The amount ıf energy released in the fission of uranium or ılutonium is several million times as great as vould be liberated by the explosion of the same veight of TNT. This large energy release is rought about because the total mass of the ission fragments (and other atomic particles that ıay be formed simultaneously) is less than the ıass of the nucleus undergoing fission plus that f the neutron initiating the process. It is the mass ıat is "lost" in the fission process and appears s an equivalent amount of energy.

The actual loss of mass in the fission of ranium or plutonium is only about one-tenth of percent of the total. Thus, if all the atomic nuclei ı 1 pound of plutonium or uranium undergo ssion, the decrease of mass would be roughly 5/1000 ounce. Nevertheless, the amount of ıergy released by the disappearance of this ıantity of matter would be about the same that produced by the combustion of 1,500 ns of coal, or of 250,000 gallons of gasoline, by the explosion of more than 8,000 tons of NT.

Because of the rapidly growing series of ssions just described, several pounds of uranium plutonium could undergo fission in a millionth rt of a second. The energy-release accompany-g the fission of this material would be ormous, and its release in such a short time would result in a tremendous explosion. This effect is exactly what happens in the nuclear bomb.

CRITICAL MASS.—In reality, not every neutron set free during fission is successful in causing the fission of another nucleus. Some neutrons are captured by nuclei that do not undergo fission. Others escape and, as far as the fission process is concerned, are lost. If conditions are such that neutrons are lost at a faster rate than they are formed by fission, the chain reaction is not self-sustaining. Some energy is produced, but the amount is not large enough, and the rate of liberation would not be sufficiently rapid, to cause an effective explosion. Therefore, achieving a nuclear explosion is necessary to establish conditions under which the loss of neutrons is minimized.

The simplest way of minimizing the escape of neutrons is to increase the amount of material. As shown in figure 7-50, fission is initiated by a neutron represented by a small dot within a small circle. It is supposed that in each act of fission, 3 neutrons are emitted; in other words, 1 neutron is captured and 3 are expelled. Removal of a neutron from the system is indicated by the head of an arrow. Thus, an arrowhead within the sphere means that fission has occurred and extra neutrons are produced, whereas an arrowhead outside the sphere implies the loss of a neutron. It is evident from figure 7-50 that a much



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gure 7-50.—Effects of increased size of fissionable material in reducing the proportion of neutrons lost by escape.

greater fraction of the neutrons is lost from the smaller than from the larger sphere. The larger sphere has less surface area per unit volume; therefore, a smaller proportion of neutrons escapes.

If the quantity of uranium (or plutonium) is small, the proportion of neutrons lost by escape will be so great that the propagation of a nuclear fission chain—and hence the production of an explosion—will not be possible. Such a quantity is called a subcritical mass. As the amount of uranium (or plutonium) is increased, however, relative loss of neutrons is decreased thereby. Eventually, an amount is attained in which the chain reaction can become self-sustaining; this amount is referred to as the "critical mass" of the fissionable material.

Although a critical mass is adequate to maintain a chain reaction in a nuclear power reactor or, perhaps, for a low-order explosion, it is not enough for a high-order explosion, which calls for a "supercritical mass." A supercritical mass is one that will support a multiplying chain reaction.

Some means used to increase criticality are as follows:

- Purifying the material chemically to decrease the possibility of capture by nuclei that will not undergo fission

- Enriching the fissionable material; for example, increasing the amount of uranium 235 compared to uranium 238

- Surrounding the material with a high density material that will reflect escaping neutrons back into the material (corresponds to tamping in blasting operations)

- Increasing the density of the fissionable material

- Using shapes with a minimum surface-to-volume ratio (a sphere is ideal)

ATTAINING SUPERCRITICAL MASS.—Because of the presence of stray neutrons in the atmosphere or the possibility of their being generated in various ways, a quantity of a suitabl isotope of uranium (or plutonium) exceeding th critical mass is likely to melt or possibly explode Before detonation, it is necessary, therefore, tha a nuclear weapon contain no piece of fissionabl material as large as the critical mass for the give conditions. To produce an explosion, the materia then must be made supercritical; that is, large than the critical mass and in a time so short a to preclude subexplosive change in the configura tion, such as by melting.

Two methods are used to bring about nuclear explosion; that is, to quickly convert subcritical system into a supercritical one. In th first method, two or more pieces of fissionabl material, each less than a critical mass, ar brought together very rapidly to form one piec that exceeds the critical mass. This end is achieve in a gun-barrel device, in which a high explosiv blows one subcritical piece of fissionable materia from the breech end of the gun into another sub critical piece firmly held in the muzzle end. (Se fig. 7-51.)

The second method makes use of th knowledge that when a subcritical quantity of a appropriate isotope of uranium (or plutonium is strongly compressed, it can become critical o supercritical. The reason is that by compressin the fissionable material (that is, by decreasing it surface area and increasing its density), the rat of production of neutrons by fission is increase relative to the rate of loss by escape. A multiplyin chain reaction may then become possible with th same mass that was subcritical in the uncompresse state.

In a fission weapon, compression is achieve by means of a spherical arrangement of speciall

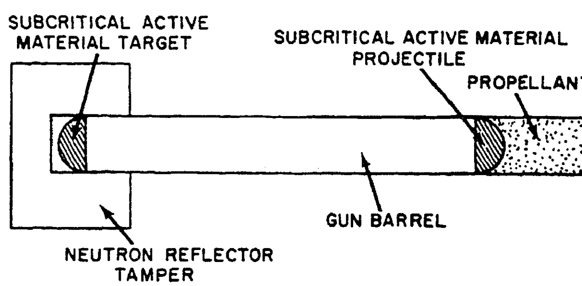

Figure 7-51.—Gun type weapon makes a supercritical ma from two subcritical masses to set off a chain reaction

fabricated shapes of an ordinary high explosive. In a hole in the center of this system is placed a subcritical sphere of fissionable material (fig. 7-52).

The high explosive is discharged by means of several detonators imbedded in the explosive and attached to an electronic firing device. This arrangement ensures that all detonators are set off at the same instant and a smooth shock wave moves inward, striking the active material (uranium or plutonium) with equal force at all points. As a result of the implosion, the active material is compressed, increasing its density; and a multiplying chain reaction begins automatically.

Fusion

In nuclear fusion, a pair of light nuclei unite (or fuse) together to form the nucleus of a heavier atom. An example is the fusion of the hydrogen isotope known as deuterium, or heavy hydrogen. Under suitable conditions, two deuterium nuclei may combine to form the nucleus of a heavier element (helium), at the same time releasing a neutron and a quantity of energy. This thermonuclear fusion reaction is expressed by the equation

$$H^2 + H^2 = He^3 + n + 3.2 \text{ MeV}$$

The 3.2 MeV is the energy liberated, expressed in million-electron-volt units. (One MeV equals 1.6×10^{-6} erg.) Weight for weight, fusion of deuterium nuclei produces nearly three times as much energy as fission of uranium or plutonium.

Nuclear fusion reactions can be brought about only in high temperatures (several million degrees), and thus they are referred to as thermonuclear processes. The only practical way in which such temperatures can be obtained is by means of a fission explosion. Consequently, by combining a quantity of deuterium or tritium (or a mixture) with a fission device, you can initiate the thermonuclear fusion reaction given in the foregoing equation (or one similar).

In fusion processes involving nuclei of the hydrogen isotopes, neutrons of high energy are liberated. It is possible, therefore, for you to make use of the thermonuclear neutrons by surrounding the fusion weapon with a blanket of ordinary uranium. High-energy neutrons are then captured by uranium 238 (U238) nuclei; these nuclei undergo fission, thereby contributing to the overall energy yield of the explosion and also to the residual nuclear radiations arising from the fission products. In general, the explosion of a thermonuclear weapon produces roughly equal amounts of energy from fission and fusion processes.

Nuclear Radiation

Nuclear radiation, as explained before, consists of alpha and beta particles, neutrons, and gamma rays. These radiations originate in the nuclei of atoms, thus the term *nuclear radiation.* Because of the nature of the phenomena associated with a nuclear explosion (either in the air or near the surface), it is convenient to divide nuclear radiation into two categories—initial and residual.

All nuclear radiations are emitted from the fission process itself or from the resulting radioactive residue, the bulk of which are in the fission fragments, which, in turn, are part of the fireball. Initial radiation is emitted from the fireball and radioactive debris during the first

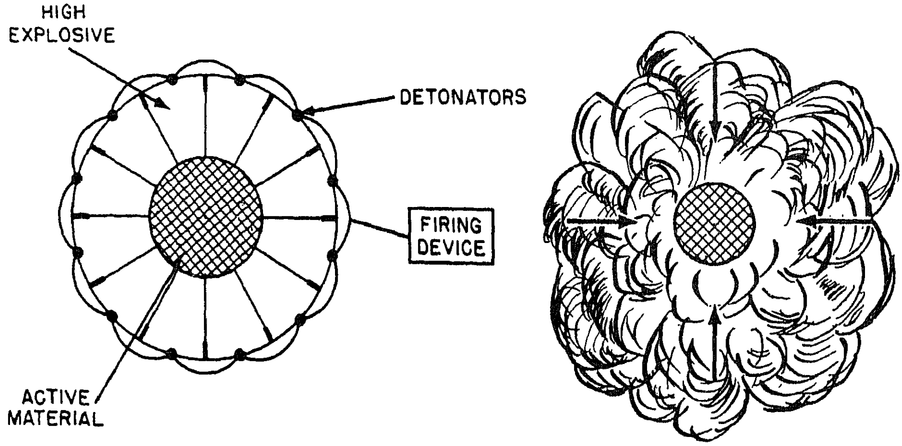

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Figure 7-52.—Implosion-type weapon increases

minute after the explosion. Radiation emitted thereafter is residual radiation. The reason for dividing the two at this time is because after about 1 minute, the fireball or radioactive cloud will have risen so high that the effects of radiation on the ground will be insignificant until fallout begins to settle.

INITIAL NUCLEAR RADIATION.—Alpha and beta particles are extremely short ranged and can be ignored as initial radiation. Neutrons and gamma rays, however, can travel great distances (especially gamma rays) and penetrate considerable thicknesses of material. Although they can neither be seen nor felt by human beings, both gamma rays and neutrons can produce harmful effects, even at great distances from their source.

Neutrons are emitted in the fission (or fusion) process simultaneously with the explosion. Afterwards they constitute no potential hazard, because they are not emitted as natural radioactive decay from the fissionable material that did not undergo fission. The capture of those emitted neutrons by air atoms also gives rise to gamma rays, which can significantly increase the gamma dose. Consequently, we can assume that neutrons are a hazard only during the initial nuclear radiation phase and then only in the general area of ground zero.

RESIDUAL NUCLEAR RADIATION.—There are three sources of residual nuclear radiation. The major source is fission fragments. Other sources are fissionable material that did not undergo fission and induced radioactivity. Fission fragments are fission product nuclei formed when uranium or plutonium nuclei capture neutrons and suffer fission. The uranium or plutonium nuclei split up into many kinds of fission fragments; these fragments are the nuclei of radioisotopes of well-known, lighter elements. The accompanying radioactivity usually is manifested by emission of negatively charged beta particles, which are identical with electrons. This breakdown frequently, though not always, is accompanied by gamma radiation, which serves to carry off excess energy.

As noted, gamma rays are energy; beta particles are high-speed electrons; and alpha particles are composed of 2 protons and 2 neutrons. Neutrons and protons are about 1,800 times larger than electrons; hence, an alpha particle is 4 × 1,800 or about 7,200 times larger than are beta particles. Gamma rays, of course, have no bulk.

Because of their greater mass and charge, alpha particles are much less penetrating than beta particles or gamma rays of the same energy. Thus, very few alpha particles from radioactive sources can travel more than 1 to 3 inches in air before they are stopped. These particles cannot get through the unbroken skin nor penetrate clothing. Consequently, the uranium or plutonium present in the fission residues does not constitute a hazard if it is outside the body. However, if plutonium, in particular, enters the body in sufficient quantity by ingestion, inhalation, or through skin abrasions, the effects may be serious.

INDUCED RADIOACTIVITY.—One other source of residual nuclear radiation remains to be discussed. The neutrons liberated in the fission process, but not involved in the propagation of the fission chain, are ultimately captured by the weapon materials through which they must pass before they can escape, by nitrogen and oxygen in the atmosphere, or by various elements present in the earth's surface.

As a result of capturing neutrons, many substances become radioactive. They consequently emit beta particles, and frequently gamma rays, over an extended period of time after the explosion.

Such radioactivity is referred to as induced radioactivity and is most prevalent in nuclear explosions occurring near the earth's surface. Here the neutrons are captured by such elements as sodium, manganese, silicon, and aluminum in the soil and hydrogen, sodium, and chlorine in water. As a result of neutron capture by an element in the soil (or atmosphere), an unstable radioactive isotope of the same element usually is formed. Radioactive decay follows, resulting in the emission of beta particles and gamma rays. To illustrate, when the element manganese (in the soil) captures an escaping neutron, the radioisotope manganese 56, with a half-life of 2.6 hours, is formed. Upon decay, it gives off several gamma rays of high energy, in addition to beta particles.

NUCLEAR WEAPONS EFFECTS

When a nuclear device detonates in space, in the atmosphere, at or below the surface of the

earth or ocean, many characteristic effects are produced. Some effects such as nuclear radiations and expanding debris are common to all environments, though varying in degree; other effects, such as cratering, blast and water shock, are peculiar to certain environments. Effects such as light and heat are visible or tangible; others, like nuclear radiations, are not directly apparent and can only be discerned by instruments or secondary effects. Some effects occur in and last only microseconds; others linger for days, months, or even years. Meteorological conditions, such as atmospheric pressure, temperature, humidity, winds, and precipitation, may affect some of the observed phenomena. All nuclear detonations, however, produce effects that can damage equipment and injure personnel.

The energy released from a nuclear detonation in the atmosphere below an altitude of approximately 100,000 feet may be divided into three broad categories. Approximately 35 percent of the energy will be used in the production of thermal radiation, 10 percent in the production of residual radiation, 5 percent in the production of initial radiation, and 50 percent in the production of blast and shock. In considering the operational significance, you may subdivide nuclear radiation into two types—initial and residual. Initial radiation is delivered simultaneously with the detonation and cannot be avoided by maneuver or evasive action. The initial radiation dose received will occur within 1 minute after the explosion, and most of it will occur within a matter of seconds. Residual radiation, on the other hand, may be emitted over a long period of time extending to days and years. Hence, maneuver out of an area contaminated by residual radiation may be an effective countermeasure.

When the detonation occurs within the earth or water, some of the energy released may be captured. For example, little or no thermal or initial radiation energy may escape from an underwater or underground burst.

The significant military effects of nuclear weapons are summarized in subsequent paragraphs to provide a general understanding of each effect, but other publications should be referred to for complete information on phenomena and for the quantitative change to a particular effect.

The energy yield of a nuclear weapon is described in terms of the amount of TNT that would be required to release a similar amount of energy. Thus, a nuclear weapon capable of releasing an amount of energy equivalent to the energy released by 20,000 tons of TNT is said to be a 20-kiloton (20-KT) weapon. A nuclear weapon capable of releasing an amount of energy equivalent to the energy released by 1 million tons of TNT is said to be a 1-megaton (1-MT) weapon.

Weapon yields may range from a fraction of a KT to many MTs. Although a weapon's total yield is not significantly influenced by the environment about the burst point, the relative importance of weapon effects depends greatly on where the detonation takes place. It is useful to define five basic types of bursts:

1. Airburst, in which the fireball does not contact the surface
2. High altitude burst, in which the explosion takes place at an altitude in excess of 100,000 feet
3. Surface burst, in which the fireball touches or intersects the surface
4. Underwater burst, in which the point of detonation is below the water surface
5. Underground burst, in which the point of detonation is below the land surface

Although the five types of bursts are defined, there is actually no clear line of demarcation between them. Obviously, as the height of burst is decreased, the high altitude burst becomes an airburst, an airburst will become a surface burst, and so on. The significant military effects associated with each type of burst follow.

AIRBURST

An airburst (fig. 7-53) produces air blast, thermal radiation (heat and light), an electromagnetic pulse, and initial nuclear radiation (neutron and gamma rays) about the burst point. There will be no significant residual nuclear radiation (gamma and beta radiations from airborne or deposited radioactive material) except when rain or snow falls through the radioactive cloud.

HIGH-ALTITUDE BURST

A high-altitude burst produces air blast, thermal radiation, an electromagnetic pulse, initial nuclear radiation, and atmospheric ionization. At altitudes above 100,000 feet, the proportion of energy appearing as blast decreases markedly, whereas the proportion of radiation energy increases. Because of the low density of the atmosphere, the range of the initial nuclear radiation increases. In contrast to explosions below 50,000 feet, the attendant atmospheric ionization from bursts above 100,000 feet lasts for minutes to hours. The important consequences of

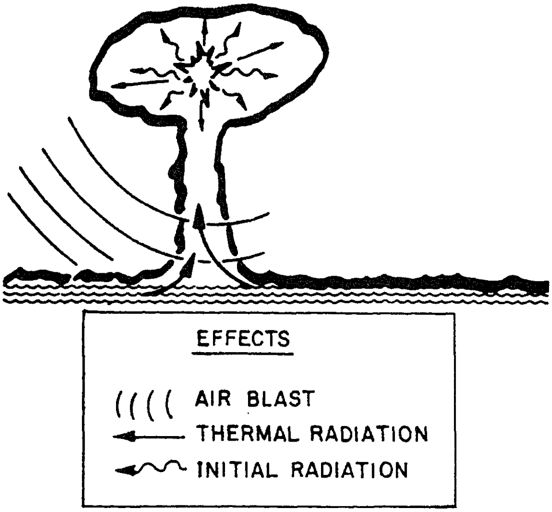

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Figure 7-53.—Airburst.

high-altitude bursts are the damage to weapons systems or satellites operating in the upper atmosphere or in space, and the effects on electromagnetic waves (communications and radar) relying on propagation through or near the region of the burst.

SURFACE BURST

A surface burst (fig. 7-54) produces air blast, thermal radiation, an electromagnetic pulse, initial nuclear radiation around surface zero (SZ), and residual (transit and deposit) nuclear radiations around SZ and downwind from SZ. Transit radiation is that produced by airborne radioactive material (base surge/fallout), and deposit radiation is that produced by radioactive material (base surge/fallout) collecting on exposed surfaces. Surface bursts over water will also produce underwater shock and surface-water waves, but these effects will be of less importance. Over land, earth shock will be produced but will not be an important effect at any significant distance from the burst point.

UNDERWATER BURST

An underwater burst (figs. 7-55 and 7-56) produces underwater shock and a water plume that then causes a base surge. Very shallow bursts may also produce air blast, initial nuclear radiation, fallout, and some thermal radiation. These effects will be reduced in magnitude from those of a water-surface burst and will become rapidly insignificant as the depth of burst is increased. The damage range because of shock is

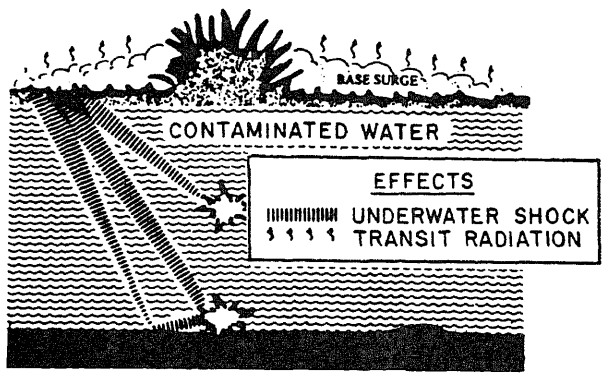

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Figure 7-55.—Deep underwater burst.

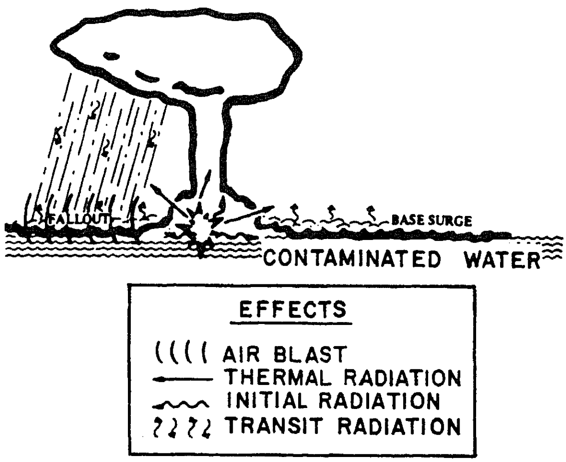

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Figure 7-54.—Surface burst.

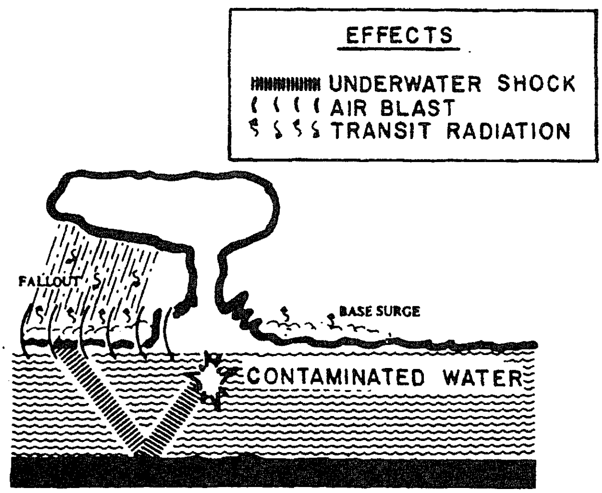

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Figure 7-56.—Shallow underwater burst.

increased as depth of burst is increased. For a given weapon yield, greater hull and machinery damage will be produced by shock from an underwater burst than by air blast from an airburst or surface burst. The reverse is true for topside equipment, such as antennas and missile launchers.

When a high-yield weapon is detonated underwater in the deep waters adjacent to a continental shelf, large breaking waves may be generated by the upsurge along the shelf slope. These waves will appear on the shallow water side of the shelf edge. They are characterized by a long period with a sharp, possibly breaking, crest. They dissipate in amplitude as they progress toward the shore. Calculations and simulation experiments with the East Coast U.S. continental shelf indicate that, in the near vicinity of the shelf edge (shallow water side only), these waves may be large enough to damage the largest combatant ships and to swamp or capsize smaller ships. This shoaling phenomenon does not appear in deep water. Except in shoaling waters, water waves normally will not be a major hazard.

UNDERGROUND BURST

An underground burst (fig. 7-57) produces severe earth shock especially at fairly close distances from the burst point. Light, heat, air blast, initial nuclear radiation, and fallout will be absent or negligible if the burst is confined below the surface. For shallow underground bursts, the light, heat, air blast, and initial nuclear radiation will be less than those for a ground surface burst. Ground shock will cause damage within about three crater radii, but little beyond. Early fallout can be significant; and at distances not too far from the explosion, the base surge (evidenced by a dust cloud) will be an important hazard.

WEAPON EFFECTS AND THEIR MODIFICATION BY THE ENVIRONMENT

Specific effects result from a particular weapon and a particular type of burst. These effects are considerably influenced by the environment in which the weapon is detonated. A description of the weapon effects and their modification by environment is provided in the following paragraphs.

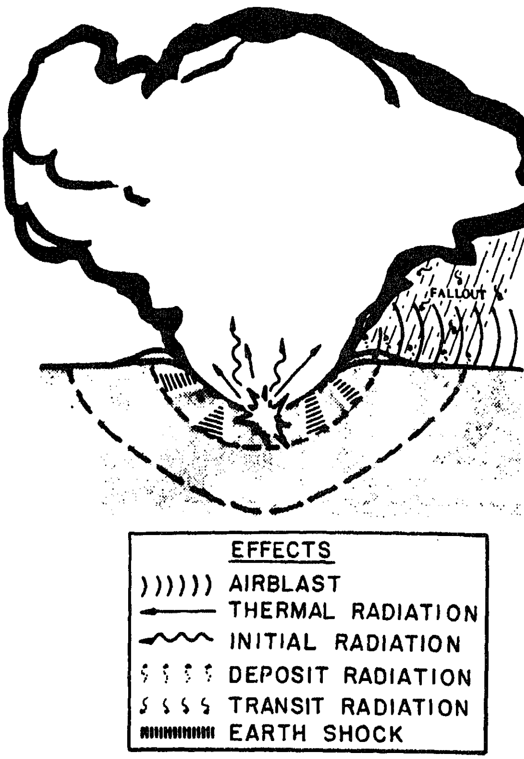

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Figure 7-57.—Underground burst.

AIR BLAST

This is the shock wave produced in air by an explosion. The air-blast wave initially travels outward at a velocity of approximately seven times the speed of sound at high overpressures and then gradually slows down to sonic speed (about 1,000 feet per second [ft/sec]) at low overpressures. Air blast produces a rapid increase in the normal atmospheric (static) pressure, and high-wind (dynamic) overpressures result. High-static overpressures damage by squeezing and crushing targets; dynamic overpressures damage by bending or dragging targets. Ship structures and buildings are primarily vulnerable to static overpressures; aircraft, masts, antennas, and exposed personnel are vulnerable to dynamic overpressures.

Air blast is measured in pounds per square inch (psi) over the ambient or atmospheric pressure. Damage produced by air blast is related to peak static and dynamic overpressures.

UNDERWATER SHOCK

Underwater shock is the shock wave produced in water by an explosion. The shock wave

initially travels several times the speed of sound in water but quickly slows down to sonic speed (approximately 5,000 ft/sec). Underwater shock produces rapid accelerations that may result in equipment and machinery disarrangements, hull rupture, and/or personnel injuries. Both the directly transmitted shock wave and the shock wave reflected from the sea bottom can be damaging. An underwater explosion produces a shock wave similar to an air burst. However, underwater shock damage is measured by the peak vertical (for surfaced ships) and peak translational (for submerged submarines) velocities rather than by the water overpressures produced by the shock front. Figure 7-58 shows the direct and reflected shock waves.

Four factors determine whether the greater damage will be caused by the direct wave or the reflected wave:

1. Distance from burst
2. Depth of burst
3. Depth of water
4. Bottom configuration and structure

When a burst occurs above the bottom, the shock wave reflected from the bottom may produce more severe damage to weapon-delivery

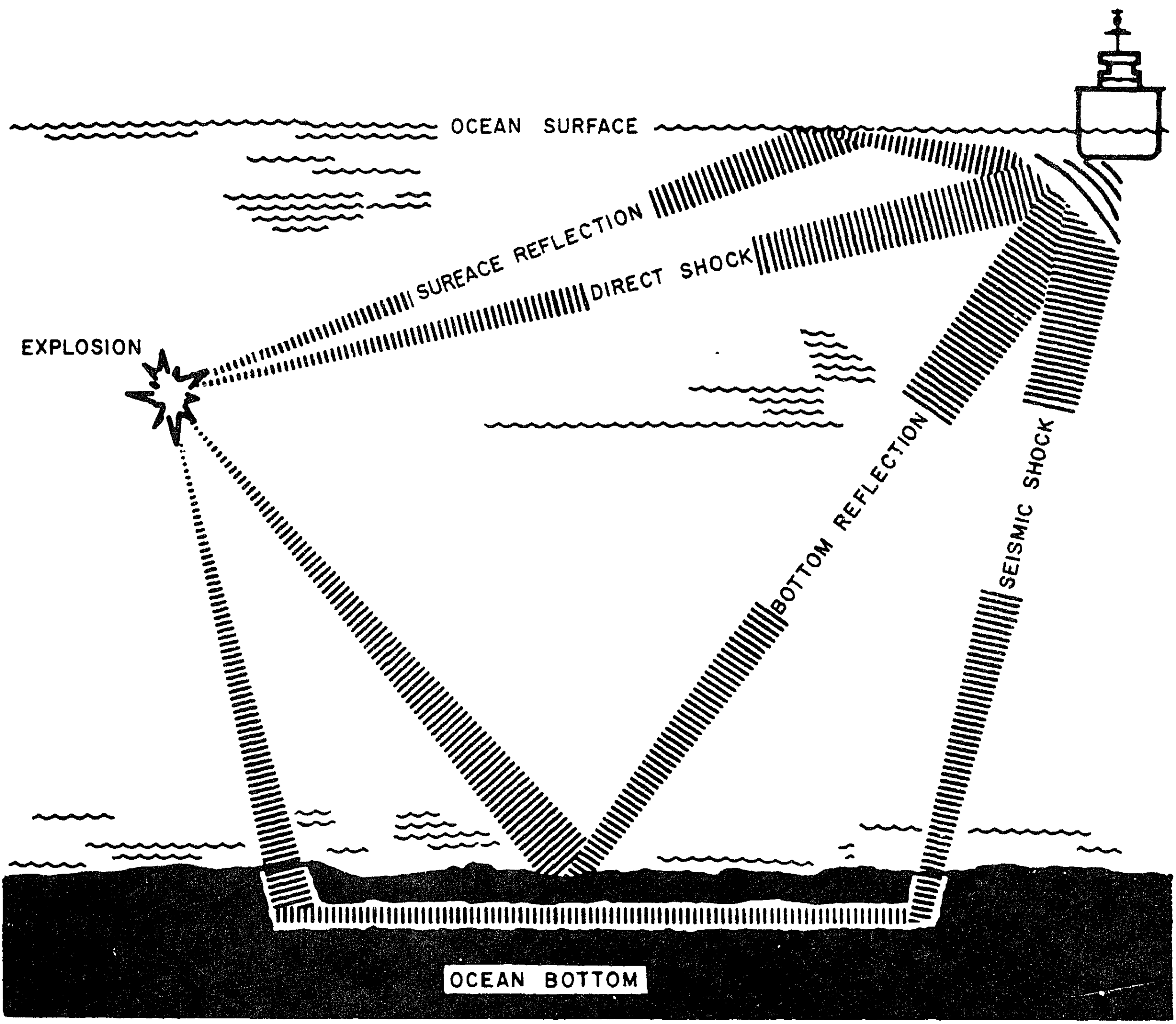

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Figure 7-58.—Direct and reflected shock waves for an underwater burst.

equipment at a given range than the direct shock wave. Even though the peak pressure of the reflected wave is less than that of the direct wave, the reflected wave propagates in a more nearly vertical direction and, hence, is more effective in producing the vertical motions that control the degree of damage.

The time separation between direct and reflected shock waves decreases as the position of a burst approaches the bottom. For a burst directly on the bottom, the two waves overlap. For such a burst, the water depth has a direct effect on the range at which weapon-delivery capability of surface ships will be impaired, but has no significant effect on the ranges at which their mobility and seaworthiness will be impaired. Where the sea bottom is sloped, a ship downslope from the burst point will tend to receive less damage than a ship an equal distance upslope from the burst point. Where the sea bottom is essentially flat, the strength of the reflected wave will depend on the bottom structure. It will be less for mud than for sand, but greater for rock than for sand.

THERMAL RADIATION

Thermal radiation is the radiant energy (heat and light) emitted by the fireball. Thermal radiation travels at the speed of light and persists as long as the fireball is luminous. The duration of thermal radiation emission depends on weapon yield; it lasts less than 1 second for a 1-KT yield and approximately 8 or 9 seconds for a 1-MT yield. Thermal radiation is effectively shielded by anything that will cast a shadow (opaque materials). Thermal radiation can produce combat ineffectives (CI)—any individual who is unable to man his battle station—among exposed personnel by skin burns, flash blindness, or retinal burns.

Over land areas, thermal radiation will initiate fires in buildings, vehicles, vegetation, and other combustible materials.

Thermal radiation is modified by the height of burst, weapon yield, atmospheric transmissivity, cloud cover, and terrain features. As height of burst is increased, the area of the earth's surface exposed to thermal radiation increases because there are less shadows from existing structures, vegetation, terrain features, and so on.

As weapon yield increases, the range at which thermal radiation is capable of causing skin burns and eye injuries to exposed individuals extends well beyond the range where blast and initial nuclear radiation are of significance. The rate at which thermal radiation is emitted from a high-yield weapon is lower than for a low-yield weapon. Thus, the high-yield weapon must deliver more thermal energy to do an equivalent degree of damage because a target has more time to dissipate the heat being received.

Atmospheric attenuation of thermal radiation depends on such factors as absorption by water vapor, carbon dioxide, ozone, and impurities in the air. On days when fog, haze, clouds, and so on, exist between the point of burst and the receiver, the thermal radiation will be decreased. On the other hand, when fog, haze, clouds, and the like, are above the burst and target, significant amounts of thermal radiation can be reflected and will increase the degree of burns received at a location. Such highly scattering atmospheres can also increase the number of personnel flash blinded or dazzled by a burst (impairment of visual acuity). The terrain surface cover, such as snow, can also reflect significant thermal radiation, adding to both the range and severity of the thermal effect.

NUCLEAR RADIATION

Nuclear radiation given off during a nuclear explosion consists of four basic types: alpha particles, beta particles, gamma rays, and neutrons.

Alpha particles do not travel more than a few centimeters in air without being stopped. They cannot penetrate even a thin sheet of paper.

Beta particles may travel several feet in air, but they cannot penetrate a sheet of aluminum more than a few millimeters in thickness. Beta particles cannot penetrate the normal combat uniform.

Gamma rays are a form of electromagnetic radiation, indistinguishable from X-rays. Neutrons are electrically neutral particles. Gamma rays and neutrons can travel comparable distances in air, up to several hundred meters. Gamma rays and neutrons have the greatest penetrating power of all the forms of nuclear radiation, and their injurious effects on personnel are quite similar.

Nuclear radiation does not affect most materials in any visible manner. Thus the essential value of ships, vehicles, electronic equipment (except transistors) and other equipment is not impaired by radiation. However, radioactive contamination does pose a danger to operating personnel. The term *contamination* is used to mean radioactive material that has

All radioactive contamination gives off nuclear radiations.

ATMOSPHERIC IONIZATION

Atmospheric ionization is an increase in the density of electrons in the atmosphere in the vicinity of a nuclear burst. These electrons affect radio and radar signals by removing energy from the waves, thus attenuating the signals, and by refracting the wave front; that is, the direction of propagation is changed. For detonations below 100,000 feet, this effect disappears in a matter of seconds. At higher altitudes the effect may last up to several hours. The effect can be of considerable importance where communications are over a long range and where radar targets are in or above the ionized layer.

ELECTROMAGNETIC PULSE

An electromagnetic pulse (EMP) will be produced by high altitude, air, and surface bursts. The initial nuclear ionizing radiation will ionize the atmosphere around the burst point and produce the EMP, which will contain frequency components in the range from a few to several hundred kilocycles per second. The EMP has magnetic and electric field components that exist for only fractions of a second. The magnetic field component is significant inside the radius of the ionized atmosphere and can induce large currents in cables and long-lead wires. These large transient currents may "burn out" electronic/electrical equipment. The electric field component may also produce transient signal overloads and spurious signals on communication nets and in computer-driven systems. At ranges where ships suffer minor damage from other weapon effects, the major effect of the EMP is expected to be the tripping of circuit breakers and blowing of fuses in protective circuitry. At closer ranges, there is a good probability of permanent damage to electronic/electrical equipment.

INITIAL NUCLEAR RADIATION

Initial nuclear radiation is defined as the radiation (essentially neutrons and gamma rays) emitted by the fireball and the cloud during the first minute after detonation. All significant neutron radiation is emitted in less than 0.1 second and gamma radiation up to 20 or 30 seconds, depending on weapon yield. The time interval of 1 minute is taken as the maximum time for the nuclear cloud to rise beyond the range in air at which gamma radiation is a significant hazard. Initial nuclear radiation generally may not produce significant material damage but will produce combat ineffectiveness.

FALLOUT

Fallout, a major effect of a shallow underground and underwater burst, is the radioactive material that falls from the nuclear cloud and deposits on exposed surfaces. The fallout primarily consists of fission products (gamma and beta emitters) mixed with material vaporized by the fireball and drawn up into the nuclear cloud. Fallout, whether airborne or deposited, is a hazard because it emits gamma radiation that can penetrate ship structures, buildings, aircraft, and so on, and reach personnel, causing radiation injury, incapacitation, or death. Deposited fallout, in addition, presents a personnel contamination hazard. The militarily significant fallout, often called early fallout, is usually deposited in less than 24 hours in an area downwind of SZ.

The area of fallout is determined by the wind structure up to the top of the cloud. In complete calm the fallout pattern is roughly circular. A constant wind direction leads to an elongation of the pattern. Complicated wind patterns (wind shear), as well as variations in wind pattern in time and space, lead to complicated ground patterns. Fallout is difficult to predict accurately except under calm and stable wind conditions.

Reduction in yield or changing the height/depth of burst to a point where the fireball does not intersect the ground will reduce fallout, as will complete containment of an underground burst.

Fallout landing on water will sink and will not constitute a hazard to ships passing through the area after fallout cessation. Fallout over a land area will remain on the surface and will be a hazard to personnel living in or passing through the area. In time, the fallout on a land surface will decay to a militarily insignificant level.

BASE SURGE

Base surge from an underwater burst is a rapidly expanding cloud or mist of water droplets produced by the collapse of the water column/plume resulting from an underwater

detonation. After the early, rapid expansion of the visible base surge (2 to 4 minutes), the base surge moves downwind at the speed of the surface wind and becomes invisible in 10 to 25 minutes. The radioactivity initially occupies about the same volume as the visible base surge; but as the water droplets evaporate, the radioactive particles and gases remain in the air and continue to disperse as an invisible radioactive base surge. At an early time after burst (for approximately 30 minutes), the base surge is highly contaminated with fission products and is an intense source of transit radiation.

The entry of airborne fallout and base surge contamination through the ventilation and combustion-air systems of ships and shore establishments may present a radiological hazard. In some instances, such entry could concentrate hazardous amounts of contamination in ventilation ducts, boiler air passages, and interior spaces. High concentrations of radioactive material in these trunks may produce a gamma-radiation hazard to personnel working nearby. The entry and deposition of radioactive material into interior spaces may also present a beta-contact hazard, even though there may only be a minor penetrating gamma-radiation hazard. In aircraft in flight, entry of airborne radioactive materials will not be a hazard during the flight, but they may represent a hazard to maintenance personnel.

RADIOACTIVE WATER POOL

A surface or underwater nuclear detonation creates a radioactive water pool in the burst area. This pool expands rapidly outward from surface zero for about 2 minutes followed by a relatively slow expansion. At 30 minutes, dispersion of the pool and radioactive decay have reduced the hazard to tactical insignificance. During the early expansion phase of this pool, dose rates of several thousand rad/hr may exist at the water surface.

BIOLOGICAL AND CHEMICAL AGENTS

Nuclear weapons are primarily designed to cause material destruction by blast and shock. Biological and chemical substances for military use are designed primarily as antipersonnel agents. They are intended to produce casualties without the destruction of buildings, ships, or equipment.

This section presents an overview of shipboard biological warfare and chemical warfare (BW/CW) defense and countermeasures.

BW/CW DEFENSE AND COUNTERMEASURES

BW agents include a variety of microbes, and CW agents include poisons. These agents have been selected for their ability to produce temporary incapacitation, sickness, or death in personnel. Tactical use of agents are generally atomized in the air to give aerosols (microscopic airborne solid particles, fine sprays, or mists), vapors, or gases. For practical purposes, BW/CW agents in these forms are odorless, colorless, tasteless, and invisible. However, a concentrated spray of aerosol cloud may be temporarily visible adjacent to an exploded or spraying munition; in addition, most BW/CW agents produce no pain or other sensation until physiological damage is well underway. These properties allow an attacker to gain and hold military advantages of surprise and concealment.

Although BW and CW agents are entirely different in their detailed effects on the human body and in the medical treatment required, they are also very different in their speed of action; therefore, the Navy has found it useful to consider BW and CW as a single system of toxic warfare for defensive purposes. All BW or CW agents that require the individual to wear both the protective mask and protective clothing fall into the MC (mask and clothing) group. Other BW and CW agents, against which adequate protection is given by the mask alone, are in the MO (mask only) group.

BW agents are not quick-acting tactical weapons, but are best used for delayed effects against convoys, advanced bases, repair facilities, shipyards, port concentration of ships, task groups at sea, and civilian populations. CW agents, on the other hand, can be selected for either immediate or delayed action, for brief or prolonged disability, or for temporary physical or mental incapacitation. In general, CW agents are best adapted for quick antipersonnel effects. CW agents can be mixed, as can BW agents, to obtain combinations of properties to complicate and confuse the defense.

WEATHER FACTORS

The use of BW/CW agents is dependent upon weather and topography. Calm and low-velocity

winds keep the agent clouds concentrated the longest as they move downwind. Gusty and high velocity winds break up the agent clouds quickly and make it difficult to use the winds "to target" units downwind. Precipitation and the vertical temperature gradient in the lower atmosphere significantly affect the effectiveness of BW/CW attacks. Heavy and extended rain or snow will gradually wash the air clean of the agents, but short and light precipitation is of little help in cleaning the air.

Normally the air temperature decreases with an increase in altitude. The rate of temperature decrease with altitude is known as the temperature gradient. When the temperature decreases 5.5 °F per 1,000 feet of altitude in dry air or 2.8 °F per 1,000 feet in saturated air, the gradient is neutral and a neutral stability condition prevails. Neutral stability is prompted by overcast skies and a sea-surface temperature equal to the air temperature. With a neutral gradient, BW/CW agents will hang suspended with essentially no rising or falling. When the temperature gradient is larger than the figures given above, the air becomes unstable. A sea surface warmer than air, the presence of a cold air mass, and bright sun light all contribute to atmospheric instability. Agents will tend to rise continuously in unstable air. The atmosphere increases in stability as the temperature gradient decreases. In a temperature inversion, the atmosphere is extremely stable. It results from a sea-surface temperature, which is cooler than the air. Mixing of the lower atmosphere in this condition is produced only by strong winds. The agents will tend to move with little vertical spread.

SHIPBOARD VENTILATION CONTROL

All naval ships, with the exception of submarines, are continuously ventilated with weather air to some degree under all material conditions and degrees of closure presently available. Theory and practical tests show that there is no "gastight envelope" on any type of USN ship.

Ventilation rates are expressed as rates of change (R of C). An average R of C for spaces in which little heat is generated is about three minutes/change. The R of C for air-conditioned spaces is about 20 to 30 minutes/change, although the air within the air-conditioned compartment is recirculated over cooling coils at a much higher rate.

In material condition ZEBRA with X-RAY, YOKE, and CIRCLE WILLIAM fittings closed, all nonessential fans and blowers are secured. The ship is expected to be in a satisfactory condition of watertight integrity. However, it is not gastight. Air leakage in a "closed-up ship" is caused by (1) ventilation ducts without closures; (2) structural leaks (defective welds, aluminum-to-steel joints, stuffing boxes, and so on); (3) bypass leaks through doors, hatches, portholes, and closures because of worn gaskets; and (4) large leaks from breaching condition ZEBRA and unauthorized opening of doors.

The rate of increase, or buildup, of outside contamination in a ventilated compartment follows an exponential growth rule. When a ship enters a BW/CW zone, the concentration of contamination in the compartment air increases rapidly at first and then more slowly as it approaches the concentration of the outside air. As soon as the ship passes out of BW/CW-contaminated air, the concentration of the contaminant in the compartment air begins to decrease or "decay." The rate of decay follows the same exponential rule as for buildup—fast decrease at first, but gradually decreasing as the compartment contamination level approaches zero.

NOTE: One air change will produce a concentration equal to 63 percent of the external concentration; three air changes, 95 percent; and six air changes, 99.8 percent.

The most favorable ventilation control in a BW/CW situation is ventilation at the lowest practical rate while in the contaminated zone (interior concentration buildup phase), followed by the highest practical rate in clean air (interior concentration decay phase). If the ship is in the contaminated zone for six or more air changes, the compartment dosage will approach the topside dosage, but cannot exceed it.

The least favorable ventilation control in a BW/CW situation is ventilation at a high rate while in the contaminated zone, followed by a low rate as the ship enters clean air. Under these conditions, the compartment dosage may reach several times the topside dosage.

The situations described above are considered possible but difficult to achieve in practice because they presume (1) exact knowledge of the time of entering and leaving the contaminated zone or (2) the chance increase or decrease of ventilation

rate just when the ship leaves the contaminated zone.

A more probable situation is that the ship transits a contaminated zone with no knowledge of the presence of a contaminant. Assuming an unchanging ventilation rate, compartment dosages will be approximately equal to topside dosages.

It is believed that in the most probable situation in which a ship will be exposed to BW/CW-contaminated air, that thorough indoctrination, full intelligence data, and alert observation, even in the case of BW, will result in some clues as to the existence of contaminated zones. These clues, considered together with the other elements of the tactical situation, can be applied to best advantage by minimizing ventilation rates during the period of suspected exposure to contaminated air and subsequently maximizing ventilation rates for a period of 6 to 12 air changes in clean air.

Part of the information above, in the absence of more exact and specific information, will be related to the effect of sunlight on airborne microbes. That is, in areas of possible or probable BW exposure, ventilation should be maintained at a minimum during the hours of late afternoon, dusk, darkness, and for an hour or two after sunrise, because this period is favorable to long lifetimes of airborne microbes. Similarly, if ventilation rates must be increased at some time during the 24 hours, it is believed that the safest period, from BW point of view, is from midmorning to midafternoon.

COUNTERMEASURES AT SEA

The efficiency of BW/CW countermeasures depends on the promptness with which they are started. In fact, the period between indications of impending BW/CW attack and serious—perhaps lethal—exposure of topside personnel may be too short to allow any protective actions to be started. Because the period after an attack in which useful self-aid or first aid can be started also is short, the advantages of preattack protection of topside personnel are obvious. To prevent advance protection from seriously limiting personnel performance, adequate indoctrination and regular, realistic drills or exercises are needed. Experience has proved that inexperienced personnel are at first considerably handicapped in combat operations while wearing protective clothing and masks. As personnel gain experience in performing combat duties while wearing protective clothing and masks, the handicaps are reduced.

Measures that protect the ship structure itself from contamination also are easier, simpler, and quicker than decontamination after an attack. Ship-protective actions are of two kinds: use of the washdown system, which protects the exterior surfaces with a moving film or shield of water, and use of the system of closures, regular and jury-rigged, which can minimize penetration of aerosols and gases into the ship. In these actions, as in those which are directly personnel protective, promptness of execution is the major factor in effectiveness. Specifically, drops and sprays of CW agents cannot lodge on or contaminate a ship that is prewet or covered with the washdown shield; they are flushed harmlessly into the sea. In contrast, when deposited on dry surfaces of the ship, the same oily drops or sprays of CW agents are only partially removed by washdown; much of the remainder soaks into the paint and is removed only gradually by evaporation. The same principle of prompt action governs the use of ship-closure devices. If the ship is not already closed down tightly when a BW/CW attack occurs, the advantages of tight closure during or after an attack are unpredictable. Post-attack closure for an extended period may even increase the severity of exposures or dosages for below-deck personnel.

You should recognize that the washdown shield is the flowing film of water on ship surfaces. Where the film is lacking, there is no shield. While the washdown spray is in the air, it has little or no shielding effect against aerosols or spray.

SHIPBOARD BW/CW DEFENSE SYSTEM

The shipboard BW/CW defense system consists of the following items and procedures:

- Protective mask
- Impregnated clothing
- Wet-weather clothing
- Interior decontamination
- Topside decontamination
- Decontamination of clothing, masks, food, and water
- Personnel decontamination
- Detection
- Self-aid and first aid

The shipboard defense system is illustrated by figure 7-59.

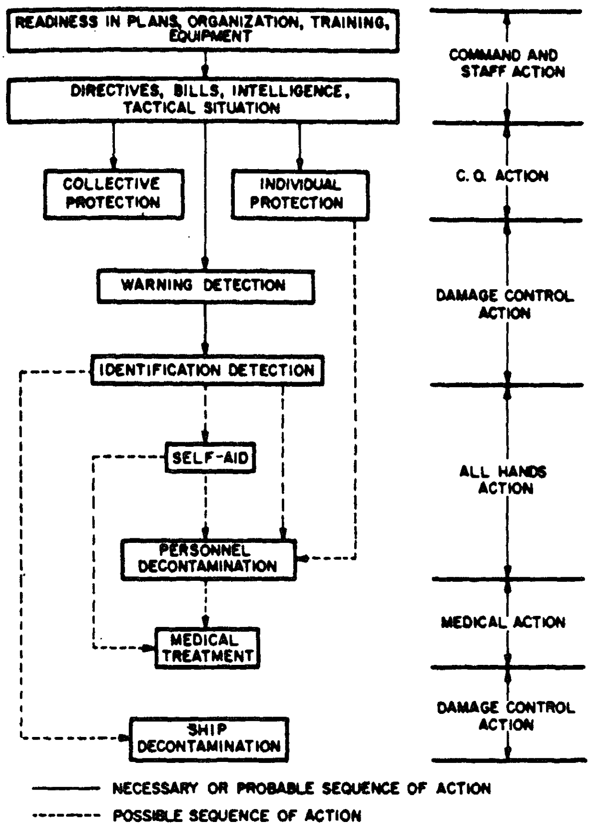

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Figure 7-59.—The shipboard BW/CW defense system.

BIOLOGICAL OPERATIONS

Biological operations are the use of living agents, such as bacteria, viruses, and other pathogenic microorganisms, to produce disease or death of humans, animals, or plants.

The possible use of biological agents is a threat that must be recognized and prepared for by all personnel. A large part of the defense against biological agents must depend upon the individual's ability to protect himself and to carry on his duties in the presence of such agents.

TYPES OF BW AGENTS

Although biology deals with all living organisms, we are concerned here with military biology; that is, only those organisms that will adversely affect people, animals, or plants. Included are the following:

1. Microorganisms (bacteria, viruses, rickettsiae, fungi, protozoa)
2. Vectors of disease (insects, acarid [ticks and mites], animals)
3. Pests (of animals and plants)

Microorganisms

Microorganisms are minute living organisms, which usually can be seen only with the aid of a microscope. Each organism is composed of a single cell or a group of associated cells capable of carrying on all functions of life, including growth and reproduction. Microorganisms do not have a digestive tract, organs of sight, nor a heat-regulating system. Many of them resemble plant life and are regarded as being in the vegetable kingdom; some, such as the protozoa, have characteristics that place them in the animal kingdom.

Microorganisms are universally distributed in the air, water, and soil. Every cubic foot of topsoil provides a natural home for billions of soil organisms. The skin, hair, nose, mouth, and digestive tract of man and other animals harbor a considerable variety of microbes in large numbers.

Microorganisms capable of producing disease are known as pathogens. Most of these pathogens are parasites and live on or within another living organism, called a host, at whose expense shelter and nourishment are provided. Other microorganisms thrive on decaying or dead organic material, and they are known as saprophytes. Most microorganisms are non-pathogenic; that is, they do not cause disease. In fact, many of them are beneficial to both man and plant life. Certain microorganisms are responsible for producing many antibiotics, such as penicillin and streptomycin. Others are important in the production of alcoholic beverages, the manufacture of vinegar, in leather-making, and in curing cheese and tobacco, as well as in the preparation of industrial solvents.

On the basis of structural and behavioral characteristics, microorganisms are divided into five distinct kinds: bacteria, rickettsiae, viruses, fungi, and protozoa. From these broad groups may be selected agents for biological warfare.

BACTERIA are very small single-cell organisms. They may be spherical, rod-shaped, or spiral in form. They are visible under an ordinary microscope. They are present everywhere in nature—in air, soil, water, and animal and plant bodies, both living and dead. Many types of bacteria can cause infection, and the powerful toxins produced by some could be used alone for

biological warfare. (Toxins are discussed later in this chapter.)

Examples of diseases caused by bacteria are typhoid fever, meningitis, and tuberculosis.

RICKETTSIAE are usually smaller than bacteria, but still are visible under the ordinary microscope. They grow only within living cells, and are potent disease producers in man and animals. Many of them are transmitted by insect bites. Examples of diseases caused by rickettsiae are Rocky Mountain spotted fever and typhus.

VIRUSES are even smaller than rickettsiae and are not visible under the ordinary microscope. Some have been photographed through the electron microscope. Like the rickettsiae, they will grow only within the living cell. Viruses and rickettsiae are probably less well distributed than bacteria because they are more particular in their growth requirements, but it is known that they can survive for short periods in the air. Examples of virus diseases are mumps, smallpox, psittacosis (parrot fever), and influenza.

FUNGI include such plants as yeasts, molds, and mildews. These organisms are well known for their ability to spoil foods and fabrics. Generally speaking, diseases caused by fungi in humans are less severe than those produced by other microorganisms. They usually produce low-grade, mild, and often chronic diseases. A few fungi are capable of producing serious diseases, such as blastomycosis (a chronic infection affecting the skin or the lungs, bones, liver, spleen, and kidneys). Several diseases of plants are caused by fungi. Examples are potato blight, cotton root rot, corn smut, and wheat rust. Should attacks be made on food crops, certain of the agents used might be in this class.

PROTOZOA are single-celled, animal-like forms occurring in a variety of shapes and often having complicated life cycles. Some protozoa cause diseases in both man and animals. Problems of production and transmission limit their application in biological warfare, but it must not be assumed that these problems could not be solved. Examples of protozoal infections of humans are amoebic dysentery and malaria.

Vectors of Disease

Disease vectors are animal carriers that transfer infective agents from one host to another. They usually are arthropods (insects, arachnids, crustaceans) but may be other animals. They can be classified into two types—biological and mechanical. Biological vectors are animals in whose bodies the infecting organism develops or multiplies before it can be infective to the recipient animal. Mechanical vectors are animals that transmit infective organisms from one host to another but, in themselves, are not essential to the life cycle of the parasite.

Mosquitoes that transmit malaria and yellow fever are biological vectors. The black horsefly, which transmits anthrax, and many insects that transmit plant diseases also are mechanical vectors. Higher animals and humans themselves sometimes act as vectors. Swine are host to trichinae, which produce trichinosis in humans when they eat inadequately cooked, infected pork. Dogs, cats, skunks, foxes, and some other animals transmit rabies.

Pests

The meaning of the term *pest* as used herein is restricted to certain animals (excluding microorganisms) that interfere with the health of other organisms by living on or within them or by associating with them in other injurious ways. Pests are known as parasites when they obtain their food from living host cells. The presence of a large number of parasites on the surface of the host's body, producing only mechanical effects, is known as infestation. Invasion of the tissues of the body of the host by parasites, producing injury followed by host reaction, is known as infection. Living organisms that consume or destroy food, clothing, and forest products also are characterized as pests.

Although many insects are beneficial to agriculture, great losses are caused by plant-feeding insects and by insect-borne plant diseases. Other serious losses result from the destruction of stored food, clothing, and forest products by such pests as rats and moths. Some pests affecting the animal kingdom are mites, ticks, spiders, scorpions, chiggers, lice, bedbugs, and flies. Some pests affecting plants are the Japanese beetle, snail, corn earworm, boll weevil, elm leaf beetle, and the like. Other pests that take their toll of man's products and have potential value as BW agents are rats, mice, groundhogs, starlings, and crows.

EFFECTS OF BIOLOGICAL AGENTS

Biological agents may be selected to produce various strategic or tactical goals, ranging from brief but crippling diseases to widespread serious illnesses with many deaths. The effects of

biological agents vary widely, depending upon the agent or agents selected.

The mere presence of a disease-producing organism on or in the body of a host does not guarantee that infection or illness will result. In fact, pathogenic organisms are frequently present in the human body for long periods of time, causing no harm to the person carrying them. The factors that determine whether infection will result from contact between a pathogen and a host are not completely understood, but the following are known to be important: (1) the general state of health of the individual, (2) the immunity of the particular individual to the particular organism, (3) the number of organisms to which the individual is exposed, and (4) the ability of the organism to cause disease.

It is important to remember that the effects of pathogens are always delayed. There is always an incubation period between the time organisms enter the body and the time that symptoms of disease are observed. The incubation period may vary from several hours to several weeks.

To some extent, the effects of pathogens are determined by the route by which the infecting organisms enter the body. Many organisms require a specific portal of entry to produce infection or disease; others can cause disease when they enter by any route. The usual ways in which pathogenic organisms enter the body are by inhalation, by swallowing, by direct contact, and by injection. Injection includes insect and animal bites.

DISSEMINATION AND DETECTION OF BW AGENTS

Biological agents may be spread in various ways. They may be used as fillings in bombs, shells, or aerial or surface spray tanks. Biological agents may be released from munitions as aerosols, which are cloudlike formation of solid or liquid particles in which the biological agents are held suspended.

No simple and rapid methods are available for the detection of biological agents, such as those existing for the detection of chemical agents and for nuclear radiation.

The positive detection and identification of a pathogen can be obtained only by taking samples of the organisms, growing a culture of the organisms under laboratory conditions, and then subjecting the culture to a variety of biochemical and biological tests. As may be seen, the final identification of pathogens is a problem for medical personnel.

CHEMICAL OPERATIONS

In chemical operations, death, injury, or irritating effects are produced by toxic chemical agents. Although chemical agents are frequently referred to as gases, they may actually be found as solid particles, liquids, or gases. Chemical agents are used chiefly for their effects on personnel, although some agents also have corrosive effects on certain materials and incendiary agents will burn most materials. Chemical agents produce harmful physiological reactions when applied to the body externally, when inhaled, or when swallowed. Most military chemical agents cause disorganization of the functioning of the body.

Chemical agents can be disseminated by aircraft spray, chemical projectiles, chemical bombs, chemical grenades, smoke pots, smoke candles, chemical land mines, and missiles. The principal factors that determine the method by which a chemical agent is spread are the quantity of the agent required to accomplish specific objectives, the nature of the agent being used, the distance to the place of attack, and the speed with which the agent must be used.

BLOOD AGENTS

Blood agents enter the body via the respiratory tract. They affect bodily functions through action on the enzyme cytochrome-oxidase, thus preventing the normal transfer of oxygen from blood to body tissue. Most blood agents act rapidly and are normally nonpersistent. In general, if speedy death does not result, complete recovery from the effects of the blood agents will take place within a few hours. The most common blood agents are hydrogen cyanide (AC) and cyanogen chloride (CK).

Although AC is one of the most deadly poisons known, it is one of the least effective chemical agents because it evaporates rapidly. The vapors are less dense than air and hence fail to provide a blanket of the agent, and the poisoning effects do not accumulate as exposure continues. An interesting characteristic of CK is its ability to destroy the effectiveness of charcoal canisters of protective masks. It has a very deteriorating effect on these canisters, and they stand up only a short period of time under CK.

CHOKING AGENTS

Choking agents, sometimes called lung irritants, injure unprotected persons chiefly

in the respiratory tract; that is, in the nose, throat, and particularly the lungs, causing pulmonary edema. In extreme cases, membranes swell, lungs become filled with liquid, and death results from lack of oxygen; thus these agents choke an unprotected man. Fatalities of this type are referred to as "dry-land drownings."

The two most common choking agents are phosgene (CG) and diphosgene (DP). Use of these agents is rather limited, because they react rapidly with water to yield nontoxic hydrolysis products. Their concentrations in air are fairly rapidly reduced by water condensates (rain, fog) and by dense vegetation. Other classes of agents are much more efficient. Unlike the nerve and blister agents, choking agents have no poisonous effect upon foods; they are too readily destroyed.

VOMITING AGENTS

The most important agents of this type are diphenylchloroarsine (DA), diphenylchanoarsine (DC), and adamsite (DM). These agents are dispersed as aerosols and produce their effects by inhalation. Some minor eye irritation also might be observed.

These agents produce a feeling of pain and a sense of fullness in the nose and sinuses, accompanied by a severe headache, intense burning in the throat, and tightness and pain in the chest. Irritation of the eyes and lacrimation are produced. Coughing is uncontrollable and sneezing is violent and persistent. Nausea and vomiting are prominent. Mild symptoms, caused by exposure to very low concentrations, resemble those of a severe cold. The onset of symptoms may be delayed for several minutes after initial exposure, especially with DM. Effective exposure may, therefore, occur before the presence of the smoke is suspected. If the protective mask is then put on, symptoms will increase for several minutes, despite adequate protection. As a consequence, the victim may believe his mask to be ineffective and may remove it, causing further exposure to himself. On leaving the scene of the attack, the victim's symptoms subside rather rapidly, and the severe discomfort vanishes after about one-half hour. At high concentrations, effects may last for several hours. Because of their arsenical properties, these agents make foods poisonous.

TEAR AGENTS

Tear agents (also known as riot control agents) are essentially local irritants, which in very low concentrations act primarily on the eyes, causing intense pain and a considerable flow of tears; stinging of warm moist skin; and irritation of the nose. High concentrations produce irritation of the upper respiratory tract and lungs and cause nausea and vomiting. The agents may be either solids or liquids and may be dispersed in the air as vapors or smokes. Tear agents include CN, CNC, CNB, BBC, and CS. Of these agents, CS is the newest and most effective, producing immediate effects even in extremely low concentrations. About 20 to 60 seconds after exposure, a person is incapacitated, and effects last 5 to 10 minutes after the affected individual is removed to fresh air. During this time affected individuals are incapable of effective concerted action. The physiological effects include extreme burning of the eyes accompanied by copious flow of tears; coughing, difficulty in breathing, and chest tightness; involuntary closing of the eyes; and stinging sensation of moist skin. This agent is highly successful in quelling riots. Although personnel exposed to CS may shower as necessary when CS dust or particles are on the skin, showering should be delayed for 6 hours to prevent stinging and reddening of the skin.

INCAPACITATING AGENTS

Incapacitating agents were developed through intensive study and research as a means of waging and winning a war without resorting to massive killing, enormous destruction of property, and the immense monetary cost characterized by past wars and which undeniably will characterize any future conflict in which nuclear weapons are used. Incapacitating agents are the latest discovery; and many still are in the research, development, and testing stage. Much remains to be learned about them.

Effects of these incapacitating agents are not predictable and may change in any person from dose to dose. During a single exposure, a person's feelings may range from impatience, restlessness, and anxiety to an exuberant sense of happiness. He may suffer from delusions of persecution or grandeur. He may reach a catatonic state wherein he cannot move voluntarily and will hold any position in which he is placed. In this state he may suffer from hallucinations, panic, and make violent outbursts.

An agent of this type is BZ, a slow-acting aerosol. It enters the body by inhalation and interferes with mental processes that control

Although there are many unanswered questions concerning the physiological action of these incapacitating compounds, and although much research remains to be accomplished, they offer many advantages. Some of these advantages are listed in the following paragraphs:

1. They are flexible. The effects can be tailored to meet a commander's desires—ranging from drowsiness or mild hallucinations, through confusion and lack of physical coordination, to hysteria, irresponsibility, or complete withdrawal.

2. They are economical. They are far less expensive to produce, pound for pound, than fissionable materials or even some of the more advanced conventional weapons.

3. They are not destructive. An enemy nation subdued by the use of incapacitating agents against its armed forces and against its support services will not pose to the victors the mammoth problems of reconstruction and rehabilitation. Factories will remain standing; cities will still be alive.

4. They are less injurious. Properly employed, these agents are likely to cause far less loss of life, less maiming or crippling, and less permanent aftereffects than has been true of high explosives, alone, in past conflicts.

5. They are a simpler weapons system. Agents of this type are easily stored, loaded into munitions, and delivered on target. They may be projected from generators upwind of the enemy as an aerosol; they may be introduced clandestinely into the enemy's food and water supplies; they may be injected, by one well-placed agent, into the ventilating systems of large headquarters.

6. They are difficult to detect. Most agents of this type are colorless, odorless, tasteless, and produce no immediately recognizable physiological symptoms. Sprays can be made to resemble obscuring smoke; artillery shells can be designed that display the same burst characteristics as HE rounds.

Effective personal protective measures can be adopted with incapacitating agents as with other chemicals—the protective mask, protective clothing, highly sensitive alarms, or detectors.

TOXINS

Toxins are poisonous products of animal or vegetable cells, which upon being injected into animals or men cause the formation of antibodies called antitoxins. The most important toxins are those produced by bacteria, the most potent of which is botulin—hundreds of times more poisonous than phosgene, mustard gas, or cyanide, and several times more toxic than rattlesnake or cobra venom. Toxins might be used in two ways: either they could be produced outside the body and introduced into food, water, or wounds; or the organisms producing them could be used as agents. In peacetime, control is exercised over diseases of this group by taking strict sanitary measures and by enforcing a thorough medical inspection on all foods as prescribed by the Food and Drug Administration.

INCENDIARIES

Incendiary weapons, unlike other chemical agents, are concerned primarily with material damage rather than with inflicting casualties. Incendiaries have been used against personnel, of course, but their greatest application was in the destruction of industrial installations, housing ammunition, fuel dumps, and so on.

Modern military incendiaries may be divided into three categories—oil, metal, and a combination of oil and metal. They also may be divided into the spontaneously flammable materials, such as phosphorus, and those agents requiring ignition, such as magnesium and thermite.

DETECTION OF TOXIC CHEMICAL AGENTS

Attempting to identify chemical agents by sight, smell, or other sensory impressions is difficult and in some cases impossible. It is quite unreliable, and it may be fatal. Some toxic agents are so deadly and so quick acting that one brief skin contact or one small whiff of vapor can cause immediate death.

Various detection devices are available for the detection and identification of chemical agents. Most of these devices indicate the presence of chemical agents by color changes that are chemically produced.

CBR DEFENSE

All merchant officers should be familiar with procedures for defense against the effects of chemical and biological attacks and the radiation effects of nuclear attack (CBR defense).

In studying CBR defense, remember that new approaches are constantly being tried out. New weapons are being developed and new protective and defensive measures are being established all the time. Keeping up-to-date is therefore particularly important in the field of CBR defense.

INDIVIDUAL PROTECTION

Protection of personnel under NBC attack involves both individual and group measures. Individual protection is of immediate concern. What you do in the first few moments after a CBR attack may determine whether or not you will survive. Knowing the symptoms resulting from radiation exposure and from exposure to biological and chemical agents may make the difference between life and death to you. You should learn the symptoms, the action to take when you are exposed to the effects of CBR attack, and any self-aid and first-aid measures that might help you or your shipmates.

PROTECTION AGAINST AIR BLAST, UNDERWATER SHOCK, AND HEAT

Air blast produces injury among topside personnel primarily by bodily displacement (picking them up and throwing them about) and among below-deck personnel by displacement of personnel and loose gear. The severity of potential injury can be reduced if personnel hold on to solid ship structures to prevent displacement and if loose gear is secured to prevent missile hazards.

Underwater shock produces injury among topside and below-deck personnel by the mechanical transmission of the water shock force throughout the ship structure that results in rapid upward acceleration of the deck. Personnel are hit by the deck and thrown off balance, often being propelled into the overhead or into bulkheads. The severity of potential injury can be reduced if personnel hang on to solid ship structures, flex their knees, and rest on the balls of their feet. When underwater shock is expected, personnel should not lie prone on the deck because this position subjects more body area to the forces

Heat (also called thermal radiation) produces injury (skin burns and eye damage) among topside personnel and can ignite clothing or other combustibles. The severity of potential thermal injury may be reduced if personnel quickly cover exposed skin surfaces while dropping out of sight of the fireball or curling up on the deck to present a minimum target to the fireball.

Table 7-3 summarizes the action that personnel should take to reduce injury from air, surface, and underwater detonations for warning and no warning attack situations. Personnel hands-to-face evasion is practicable only for topside personnel who are alerted by the flash. The hands-to-face evasion is designed to provide protection against air blast and thermal radiation.

The maneuvers to reduce the vulnerability of topside personnel to both thermal radiation and air blast effects of air and surface bursts are given in the following paragraphs.

Personnel in open topside areas (those who can quickly drop to the deck): When you see the flash or see the sky light up, close your eyes and immediately raise your hands to cover your face. Meanwhile, drop to the deck as rapidly as possible. Do not use your hands to break your fall; use your shoulder. Curl up to present a minimum target. You may feel the heat from the detonation. Two to five seconds after the flash (depending on the weapon yield) or after the heat sensation is over, remove your hands from your face. Then immediately grab a solid ship structure

Table 7-3.—Recommended Personnel Action Against Nuclear Detonations

Burst Type	Warning		No Warning
	Topside Personnel	Below Decks Personnel	Topside Personnel
Air	A	B	C
Surface	A	B	C
Under-water	B	B	--

A — Lie prone and hold on to solid ship structure.

B — Stand with knees flexed and hold on to solid ship structure.

C — Hands-to-face evasion.

firmly to prevent the air blast winds from blowing you overboard or against the ship's structure. You may suffer flash blindness of a period up to 30 minutes.

Personnel in congested topside areas (those who cannot quickly drop to the deck; for example, as those on a gun mount): When you see the flash or see the sky light up, close your eyes and immediately raise your hands to cover your face as rapidly as possible while crouching and bending your head down. You may feel the heat from the weapon. At this point, grab hold of a solid ship structure to keep from being blown overboard or against the ship's structure by the air blast.

SELF-AID AND FIRST AID

If you or your shipmates should sustain injuries or become contaminated with radiological, biological, or chemical agents during an attack, you can increase your chances of survival by immediately administering certain self-aid and first-aid measures. Self-aid consists of those measures which persons can apply to help themselves. First aid is the assistance rendered by nonmedical personnel to a casualty until medical help arrives.

The blast and heat injuries from a nuclear explosion are treated in the same manner as those resulting from high explosive bombs, incendiary weapons, and mechanical accidents. Fractures, concussions, lacerations, contusions, hemorrhages, burns, shock, and exposure are treated in accordance with standard self-aid and first-aid measures.

There is nothing that needs to be done immediately for nuclear radiation sickness. Remember that you could receive a dose of radiation even though you are NOT contaminated with radioactive particles. If there is the possibility that you have been exposed to nuclear radiation, you will be checked by medical personnel and given appropriate treatment.

If directed, you will proceed to a personnel decontamination station where you will discard your clothing and equipment and take a shower, using plenty of soap and warm water. In washing, pay close attention to the hairy parts of your body, body creases, and fingernails, where dirt tends to gather.

Since symptoms caused by pathogenic biological agents may not appear for some time, you may not be aware that a biological attack has occurred. However, should you suspect that biological contamination has taken place, put on your protective mask and observe the basic principles of preventive medicine, which include individual hygiene, sanitation, and physical checkups. Report any illness to medical authorities immediately.

If there is a possibility that you have been contaminated by biological agents, carefully remove your clothes to avoid spreading any contamination and take a thorough soap and water shower as soon as possible. Pay careful attention to your face and hands. Use a fingernail brush to remove dirt under your nails. Brush your teeth and gums frequently and the roof of your mouth and your tongue. Change your clothes and dispose of contaminated clothing as directed.

The Department of Defense has developed a new Nerve Agent Antidote Injector (Combo-Pen) and a new skin decontamination kit (fig. 7-60). The new Nerve Agent Antidote Injector (Combo-Pen) is to be used INSTEAD OF the older Atropen Auto-injector. The M258 decontamination kit is to be used to decontaminate skin ONLY. The combination of the M258 kit and the new Nerve Agent Antidote Injector (Combo-Pen) gives you a much improved means for chemical defense. TAKE ADVANTAGE OF IT.

Pictures of the new M258 kit and the Combo-Pen are shown in these pages to familiarize personnel on the use of the equipment.

284.63

Figure 7-60.—Kit and agent.

The M258 kit has a web strap and a snap clip attached to the back (fig. 7-61) so that it can be attached to your mask carrier. The recommended way to carry the M258 kit is to slip the web strap on the kit over the D-ring strap of the mask carrier. (See fig. 7-62.)

The plastic cover of the kit has a list of contents printed on the top. The plastic T-handle of the cover is held down to the side by a piece of tape. Inside the cover is a metal cutter blade or spike. Instructions for using the kit are printed on the front. The kit contains four gauze pads, two scraping sticks, and two large plastic capsules.

Figure 7-63 shows the contents of the kit, and the ruler indicates the size of the various items. The plastic capsules hold the decontamination solutions. They are labeled I and II. Capsule I is the smaller of the two. THE KEY TO SUCCESS WITH ANY OF THESE ITEMS IS TO BE ALERT AND ACT IMMEDIATELY WHEN YOU FIND CONTAMINATION.

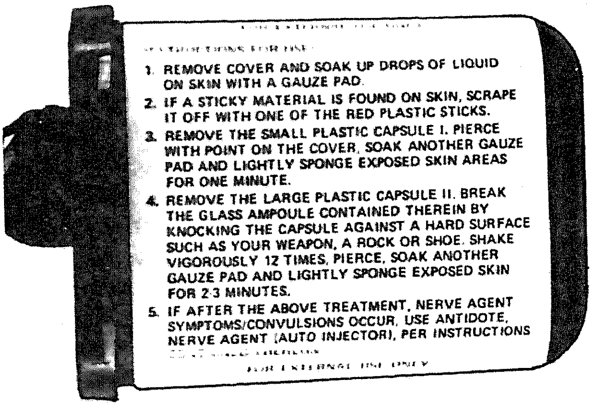

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Figure 7-61.—M258 kit and strap.

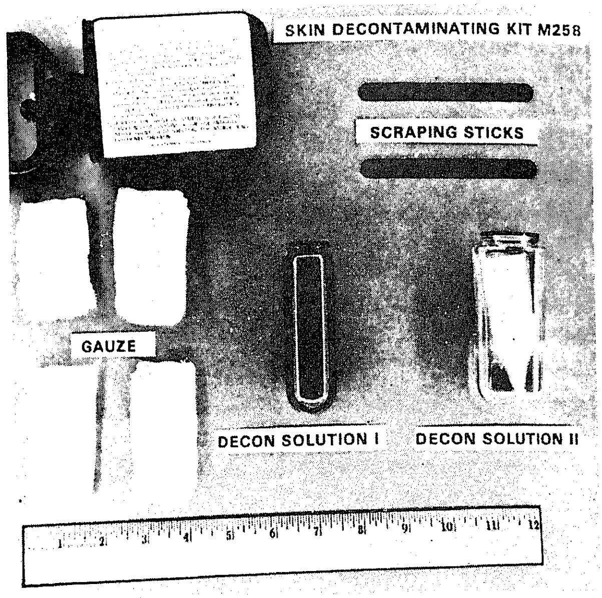

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Figure 7-63.—Contents of M258 kit.

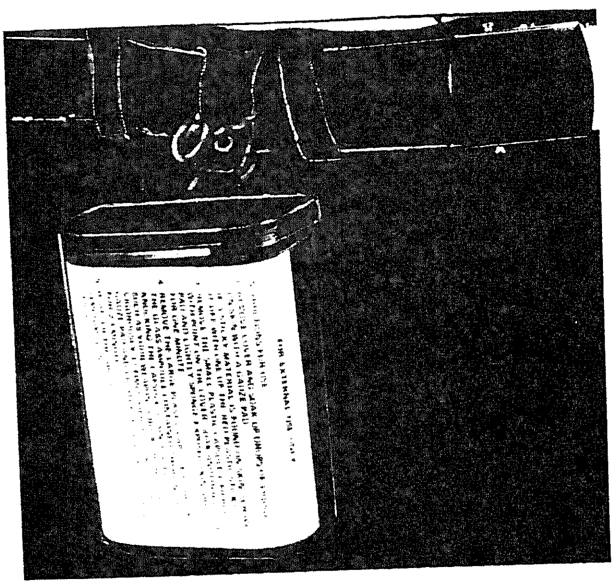

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Figure 7-62.—Carrying the M258 kit.

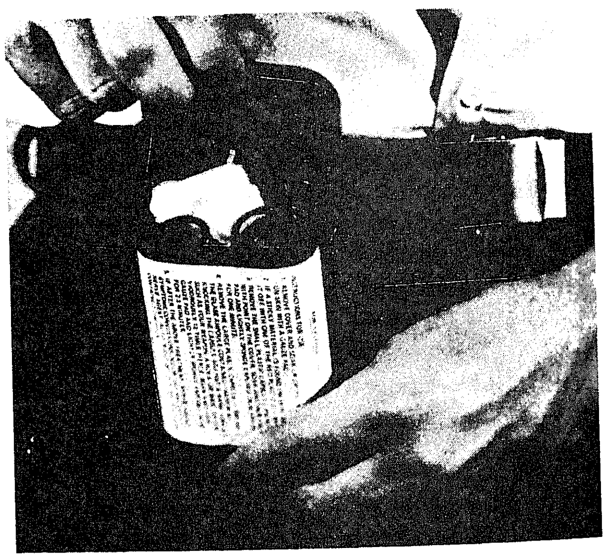

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Figure 7-64.—Opening the M258 kit.

The M258 kit will decontaminate both nerve and blister agents on your skin. The four gauze pads in the kit are used to soak liquid contamination from your skin and to swab the decontamination solutions on your skin. The gauze bags on each capsule can also be used for swabbing your skin. The two scraping sticks are used to scrape off contamination that will not soak into the gauze pads. When you see liquid contamination on your skin or the skin of your buddy, take action IMMEDIATELY.

1. Put on your mask.
2. Open your M258 kit. (See fig. 7-64.) Take the T-handle of the cover and push it through the web strap of the kit so that you do not lose it.
3. Take out one piece of gauze and soak the liquid from your skin. If one piece is not enough, use another. Throw the used gauze away after it has soaked up the liquid. If the contamination is thick and greasy and does not seem to soak into the gauze, use one or both of the scraping sticks as shown in figure 7-65 to scrape the contamination off your skin. When you have finished with the scraping sticks, throw them away.

NOTE: Be careful about where you throw the used gauze and scraping sticks. THEY ARE CONTAMINATED. You do not want them lying around where you can recontaminate yourself.

4. Take out capsule I and punch a hole in the end with the spike on the cover of the kit. (See fig. 7-66.)
5. Wet a gauze pad with the solution from capsule I. (See fig. 7-67.)
6. Slip the capsule back into the kit so that you have both hands free to work.
7. Swab or wipe the contaminated skin with the wet pad. (See fig. 7-68.)

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Figure 7-65.—Using the scraping stick.

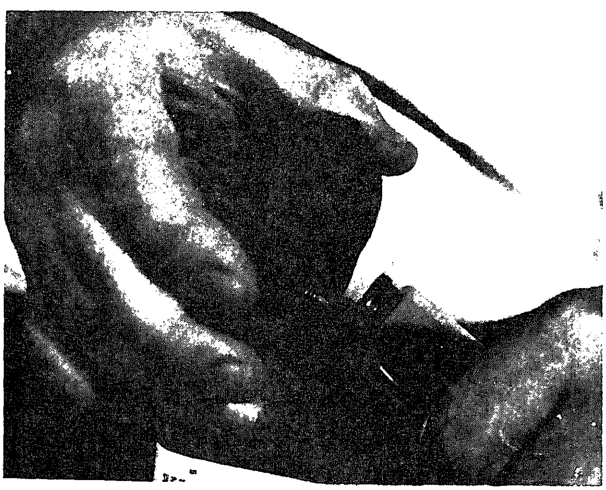

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Figure 7-66.—Punching a hole in capsule.

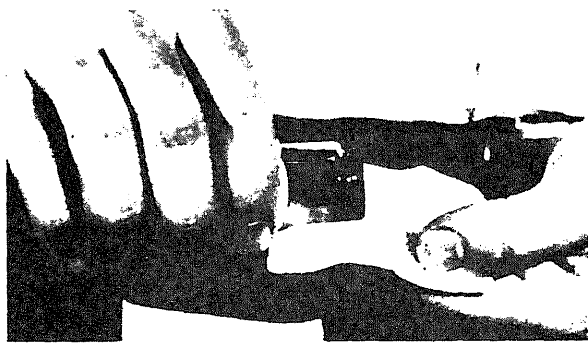

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Figure 7-67.—Wetting the gauze.

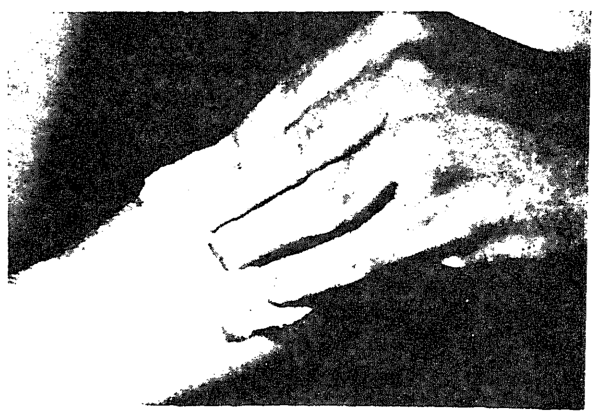

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Figure 7-68.—Wiping the contaminated skin.

8. Take out capsule II. There is a glass vial inside the capsule that must be broken. Use the heel of your boot or the bulkhead to break the vial. (See fig. 7-69.) When the vial breaks, shake the capsule 12 times so that everything in the capsule is well mixed.

9. Puncture the capsule with the spike on the kit cover and wet another piece of gauze.

10. Slip the capsule back into the kit to free both your hands and swab the contaminated skin with the wet solution II gauze. When you have finished swabbing, throw the gauze away. THAT'S IT.

Check your clothing and equipment. If your skin gets contaminated again, you will have to repeat the entire procedure with the M258 kit to decontaminate your skin. If the liquid on your skin was a blister agent and you did not see it immediately or took too long to decontaminate your skin, you might get a blister later. If you do, treat it like you would a blister caused by any other kind of burn.

Liquid blister agent in the eye that does NOT cause immediate pain is decontaminated by rinsing the eye with water for at least 30 seconds. Try to regulate the flow of water so that flushing lasts not less than 30 seconds and not more than 2 minutes. Decontamination with water effectively removes mustard, and this procedure is now standard for all agents.

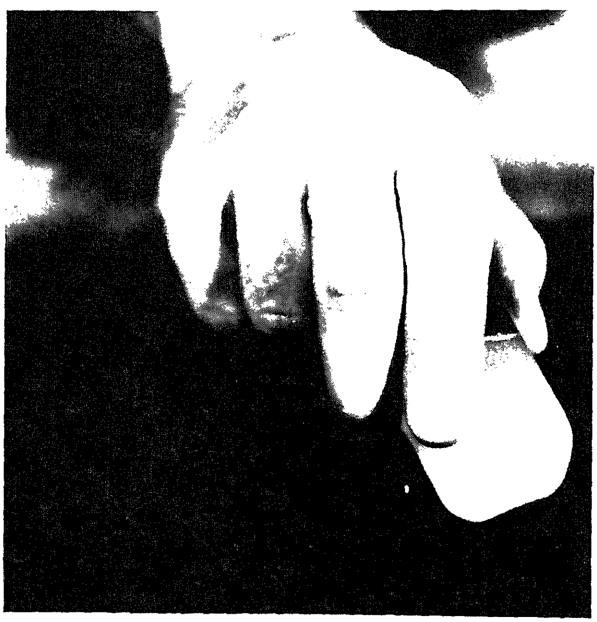

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Figure 7-69.—Breaking the vial.

The risk of leaving blister agents in the eye is so much greater than the risk of exposure to blister agent vapors during the short period of decontamination, that the decontamination procedure MUST be performed in spite of the presence of vapor.

Because PHOSGENE OXIME (blister agent) reacts rapidly with tissue, decontamination will not be entirely effective after pain has started. Nevertheless, the contaminated area should be flushed as rapidly as possible with large amounts of water to remove any phosgene oxime that has not yet reacted with tissue.

At the first sign of NERVE AGENT in the atmosphere, put on the protective mask immediately. If possible, hold your breath until the mask is on and properly adjusted. Wear the mask constantly until you are sure there is no nerve agent in the air and the all-clear signal is given.

If you were to get a liquid nerve agent on your skin and you did not notice it right away or took too long to decontaminate yourself, you might get some of the symptoms of nerve agent poisoning.

These symptoms, in usual order of appearance, are runny nose; tightness of chest; dimness of vision and contraction of the eye pupils; difficulty in breathing; drooling and excessive sweating; nausea; vomiting, cramps, and involuntary defecation and urination; twitching, jerking, and staggering; and headache, confusion, drowsiness, coma, and convulsion. All of these symptoms can take place in 30 seconds if the dose is sufficiently heavy. These symptoms are followed by cessation of breathing, then death. If you have these symptoms and are fairly sure that a nerve agent had been used, use your new Nerve Agent Antidote Injector (Combo-Pen).

The new Nerve Agent Antidote Injector is larger than the older Atropen Auto-injector and holds more nerve agent antidote. Each Navy ship will have two of the new injectors for each crew member. (See fig. 7-70.)

If the pockets of the mask carrier accommodate the Combo-Pen, the new Combo-Pen injectors are to be carried in the top outside pocket. If you find that your new injectors will not fit into the top outside pocket, carry them in the inside pocket at the rear of the carrier. Units having the USN Gas Mask ND Mark V will carry the Combo-Pen injectors inside the carrier.

The new injector works like the old Atropen Auto-injector. If you have symptoms of nerve agent poisoning, take one injector, pull off the grey safety cap, put the black end of the injector against your thigh, and press down hard. Keep

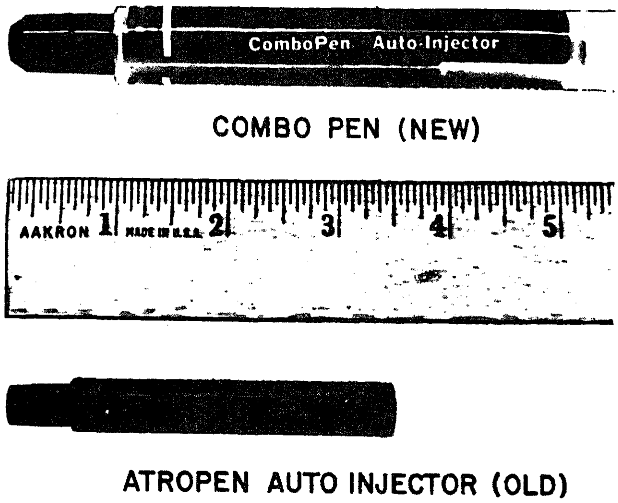

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Figure 7-70.—Antidote nerve agent injection.

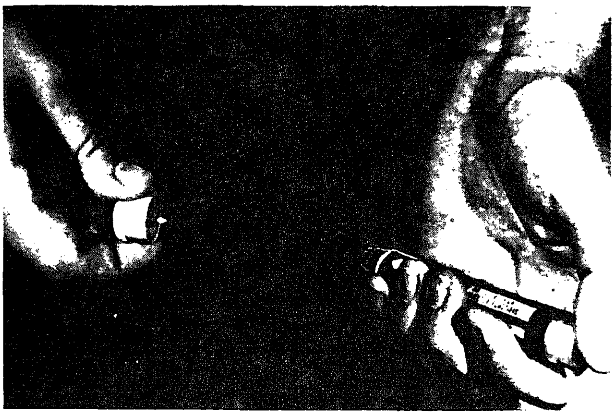

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Figure 7-71.—Injecting Combo-Pen.

the injector pressed hard against your thigh for at least 4 seconds. (See fig. 7-71.) This will ensure that you get the whole dose injected.

After you have injected yourself, go on with your mission. In about 5 minutes your symptoms should be going away. If more than 5 minutes passes and you still feel the symptoms of nerve agent poisoning, give yourself the second injector and go on with your mission.

NOTE: When the outside temperature is 45 °F or lower, take your injectors out of your mask carrier and carry them in an inside pocket close to your body so they do not freeze.

If a drop or splash of liquid nerve agent should get into the eye, instant action is necessary to avoid serious symptoms. Quickly open a container of uncontaminated water, tilt the head back so that the eyes look straight upward, and pour water slowly into the contaminated eye so that the irrigation will last not less than 30 seconds. This irrigation must be done in spite of the presence of nerve agent vapor. Hold the breath as much as possible during this procedure. If the breath cannot be held long enough to complete rinsing the eye with water for 30 seconds, rinse as long as the breath can be held, but put on the mask before breathing. After taking several breaths with the mask on, remove the mask and complete decontamination. As soon as the irrigation is completed, put on the protective mask at once. The pupil of the contaminated eye should be watched during the next minute, either in a mirror if one is available or else by someone nearby. If the pupil gets rapidly smaller, inject yourself with one Combo-Pen at once into the thigh or upper arm. If the pupil does not get smaller, the eye contamination was not by nerve agent. DO NOT use atropine until you are SURE that the symptoms are those of nerve agent poisoning.

Exposure to high concentrations of nerve agents may bring on a lack of coordination, mental confusion, and collapse so fast that a casualty may not be able to perform self-aid measures. If this happens, the necessary procedures will have to be done for the person by the nearest man who is able to do so.

Severe nerve agent exposure may rapidly cause unconsciousness, muscular paralysis, and stoppage of breathing. When this occurs, atropine alone will not save life. Artificial respiration, as a first aid measure by the nearest person able to do so, must be started immediately and must be continued until either natural breathing is restored or the casualty can be taken over by medical personnel. An atropine injection increases the effectiveness of artificial respiration and should be administered to the casualty as soon as possible, preferably by a person who is not performing the artificial respiration.

The combination of the new M258 kit and the new Nerve Agent Antidote Injector (Combo-Pen) gives you the best individual decontamination and nerve agent first-aid capability in the world today.

BUT . . . . .

THIS COMBINATION IS NO GOOD IF YOU DO NOT KNOW HOW AND WHEN TO USE IT.

Blue colored training kits are being made ng with the new olive colored M258 kits. They ould be used exactly the same as the M258 kit. aining kits can be ordered under NSN 0-00-148-7011, *Training Aid Skin Decontami-ing M258*. Have your shipmates practice using items so that if the time comes when they need m, there will not be any delay.

The speed with which the deadly effects of ne biological agents take place will require you ake immediate self-aid and first-aid measures.

In the case of BLOOD AGENTS, speed in f-aid and first aid is absolutely essential. If you ice any stimulation of breathing, an odor of er almonds, or any irritation of the eyes, nose, throat, mask at once. Blood agents act so idly that within a few seconds their effects will ke it impossible for an individual to put on the sk by himself. Try to hold the breath until the sk is on the face, if at all possible; this may very difficult, since blood agents strongly nulate respiration.

Administer first aid to any casualty who goes a coma or into convulsions or has a pink color the skin because of blood agent poisoning. ush an amyl nitrite ampoule and place it over victim's nose or under his protective mask. t squeeze the ampoule until it pops. Insert two poules inside the facepiece of the mask under eye lens. Repeat this at intervals of 3 to inutes until normal breathing returns or until otal of eight ampoules are used. Note that a ly conscious person will find it difficult or possible to tolerate high concentrations of amyl rite under his mask. If breathing has stopped, amyl nitrite treatment should be augmented h artificial respiration.

Irritation of the eyes or a change in the taste a cigarette might indicate the presence of osgene, a CHOKING AGENT. Smoking may come tasteless or offensive in taste. If any one the signs occur, put on the protective mask at e; hold your breath while doing this. Unless re is difficulty in breathing, nausea and niting, or more than the usual shortness breath on exertion, continue your normal nbat duties. If any of these symptoms occur, should rest quietly until you are evacuated medical personnel.

RSONNEL DECONTAMINATION ATIONS

Personnel decontamination stations will fer somewhat from ship to ship, but the basic requirements are the same. To prevent recontamination of personnel and ship locations, each decontamination station will be divided into two parts—a contaminated or unclean section containing a washing area and a clean section. If possible, the unclean and clean sections will have separate access routes or entrances. Showers with warm water (if possible), cleansing agents such as ear syringes, eye bath cups, hair and nail clippers, scissors, surgeon's hand soap, towels, and brushes will be provided for personnel decontamination. Radiation instruments for monitoring personnel and clothing and supplies of clean clothing will also be on hand at each station.

PROTECTIVE EQUIPMENT

It is necessary for all personnel to be familiar with the protective equipment designed for CBR defense.

PROTECTIVE MASKS

The most important single piece of equipment for individual protection against the effects of a CBR attack is the protective mask. The volume of air inhaled by a person depends upon that person's physical activity. A person at rest inhales approximately 10 quarts of air each minute, and the volume increases with physical exercise. Thus it is apparent that a considerable quantity of CBR contamination could be inhaled in a very short time. The protection mask prevents the entry of CBR contamination by filtering the air inhaled.

Filtration is accomplished in the canister of the mask by means of an efficient mechanical filter and by a chemical filter. The canister is capable of keeping out biological agents, chemical agents, and radioactive dust. Military canisters are not exhausted or deteriorated by biological agents. Their external surfaces can be decontaminated and the canister reused in an emergency. However, undue exposure to substances used in biological decontamination does affect the canisters.

The ND Mk V protective mask is currently issued to forces afloat. The mask consists of a facepiece and canister system. The facepiece provides a gastight seal around the face, protecting the eyes, lungs, and facial skin. The canister system is attached to the facepiece.

The facepiece should fit snugly over the face to provide a perfect seal. A harness assembly is provided to strap the mask to the head and to

secure it firmly. A one-way valve allows exhalation but prevents inhalation from the atmosphere. A connection assembly allows inhalation from the canister. Eyepieces are mounted in the facepiece. The ND Mk V mask also has a speaking diaphragm to allow voice communication.

A canister consists of a metal body containing a mechanical and chemical filter system. The mechanical filter is a fine screening material that collects particles—radioactive dust, solid chemical agents, biological agents, and smoke particles. Vapors are absorbed by the chemical filter, which is a high grade of activated charcoal. As vapors pass over the porous surface, they are caught in the small holes and are condensed.

The protective masks protect against most chemical agents in normal concentrations. Certain gases such as carbon monoxide, carbon dioxide, ammonia, and commercial fuel gases will pass through the canister. Therefore, special masks are required to protect against these gases.

It must be remembered, also, that the mask canister merely filters or absorbs the biological or chemical agents or the radioactive materials but WILL NOT SUPPLY OR MANUFACTURE OXYGEN. Therefore, the mask offers no protection from the hazard presented by an atmosphere that is deficient in oxygen.

The protective masks will protect you almost completely against inhalation of nerve, blood, blister, choking, vomiting, and tear agents. The ND Mk V canister is highly resistant to spray, rain, or brief immersion; however, it should be drained, wiped, and allowed to dry after such exposure. Extended immersion may damage the canister beyond repair.

Canisters come equipped with seals over the air intakes and outlets to prevent absorption of atmospheric humidity. These seals are removed and discarded when the canisters are put into use. Once unsealed and breathed through or left open for more than a few minutes, no protective mask canister should be resealed in any way.

PROTECTIVE CLOTHING

Three types of clothing are useful in CBR defense aboard ship; impregnated clothing, wet-weather clothing, and ordinary work clothing.

IMPREGNATED CLOTHING (sometimes called PERMEABLE CLOTHING) is olive green in color. A complete outfit includes impregnated socks, gloves, trousers with attached suspenders, and a jumper (parka) with attached hood. Impregnated clothing is treated with a chemical agent that neutralizes the nerve agent VX and the mustards; a chlorinated paraffin is used as a binder. The presence of these chemicals gives the impregnated clothing a slight odor of chlorine and makes them feel slightly greasy or clammy. It is believed that the impregnation treatment should remain effective for 5 or 10 years (or possibly even longer) if the impregnated clothing is stowed in unopened containers in a dry place with cool or warm temperatures and if it is protected from sunlight or daylight.

Impregnated protective clothing should not be worn longer than necessary where the threat of heat injury exists, especially in hot weather, since prolonged wearing may also cause a rash to develop where the skin is in contact with the impregnated material.

The Mk III CBR suit being introduced to fleet units will eventually replace the present impregnated clothing. This suit consists of trousers, a hip length jumper (with attached hood), and associated socks and gloves. The suit is made from a bonded, multifibre, antigas cloth that provides more effective protection against CBR agents than the impregnated clothing. Except in unusual circumstances, outer wet-weather clothing is not required to be worn over the Mk III suit, and the danger of heat prostration is significantly reduced. Outer wet-weather clothing shall be worn when raining, when exposed to the water washdown system, and when decontaminating exposed topside areas, or when otherwise deemed prudent; for example, heavy sea. While the Mk III suit can be worn for periods up to one hour in engineering spaces, with shipboard damage control condition ZEBRA and CIRCLE WILLIAM set, ventilation should be restored in training scenarios after clearing the base surge or 15 minutes, whichever is less, to preclude heat buildup and heat prostration. Each person will have a minimum of one training suit.

WET-WEATHER CLOTHING should be worn over impregnated clothing when there is a possibility of contamination by liquid chemical agents. Wet-weather clothing of stock issue includes rubber boots and gloves.

ORDINARY WORK CLOTHING provides only limited protection against liquid agents and vapors. If other protective clothing is not available, two layers of ordinary work clothing (with improvised neck and sleeve closures) will provide some protection.

DECONTAMINATION

The basic purpose of decontamination is to nimize CBR contamination through removal neutralization so that the mission of the ship n be carried out without endangering the life health of assigned personnel. The purpose of diological decontamination is to remove ntamination and shield personnel who must rk in contaminated areas. The purpose of ological decontamination is to destroy thogenic biological agents. The purpose of emical decontamination is to remove or utralize the chemical clothing agents so that they l no longer be a hazard to personnel.

Decontamination operations may be both ficult and dangerous, and personnel engaged these operations must be thoroughly trained in proper techniques. Certain operations, such the decontamination of food and water, should done only by experts qualified in such work. wever, all members of a ship's company should eive adequate training in the elementary nciples of decontamination so that they can ist in performing emergency decontamination erations.

After an attack, data from CBR surveys will used to determine the extent and degree of ntamination. Contaminated personnel must be contaminated as soon as possible. Before contamination of installations, machinery, and ar is undertaken, appraisals of urgency must be de in the light of the tactical situation.

ADIOLOGICAL ECONTAMINATION

Radiological decontamination neither utralizes nor destroys the contamination; in-ad, it merely removes the contamination from e particular area and transfers it to an area in ich it presents less of a hazard. At sea, dioactive material is disposed of directly over side. At shore installations, the problem is re difficult.

Flushing with water, preferably water under h pressure, is the most practicable way of complishing rapid decontamination of topside faces. Aboard ship, a water washdown system used to wash down all the exterior surfaces, m high to low and from bow to stern. The shdown system consists of piping and a series nozzles that are specially designed to throw a ge spray pattern on weather decks and other being built into ships under construction or conversion. Interim washdown system kits are provided for ships already in service. Air operations can now take place with the washdown system installed, because of the fact that flight decks now have nozzles installed flush with the deck.

If the washdown system is turned on before the arrival of contamination, the system prevents heavy contamination of the ship by coating the weather surfaces with the flowing stream of water. (See fig. 7-72.) The flowing water carries away radioactive particles as they fall on the ship and keeps radioactive particles from settling into cracks and crevices.

Washdown is much more effective as a preventive measure than as a decontamination measure. Even if the washdown system is used only periodically to prewet the ship and is then turned off to allow normal ship operations, the washdown is more effective than it would be if contamination had fallen on completely dry decks.

If some areas of the ship become heavily contaminated before the washdown system is activated, it will probably be necessary to hose down such areas vigorously, using seawater under pressure. Hosing should proceed from higher to lower surfaces, from bow to stern, and if possible from the windward side to the lee side. Every possible precaution should be taken to see that contaminated water does not flow back over cleaner areas. Also, precautions must be taken to see that contaminated water is not hosed into the interior of the ship through vents, doors, or hatches. The hose should be directed so that the water strikes the surface about 8 feet from the nozzle. The hose stream should sweep horizontally from side to side, moving lower on each sweep. The hosed areas should be overlapped somewhat on each sweep to ensure a complete washing. The runoff should be directed into scuppers and deck drains as rapidly as possible to keep the contaminated water moving and to prevent the formation of pools of contaminated water.

Hosing down will be most effective if it is done before metal or painted surfaces have dried after contaminating material has been deposited. However, contamination that has been deposited despite washdown will also resist hosing alone. Vigorous scrubbing with deck brushes and

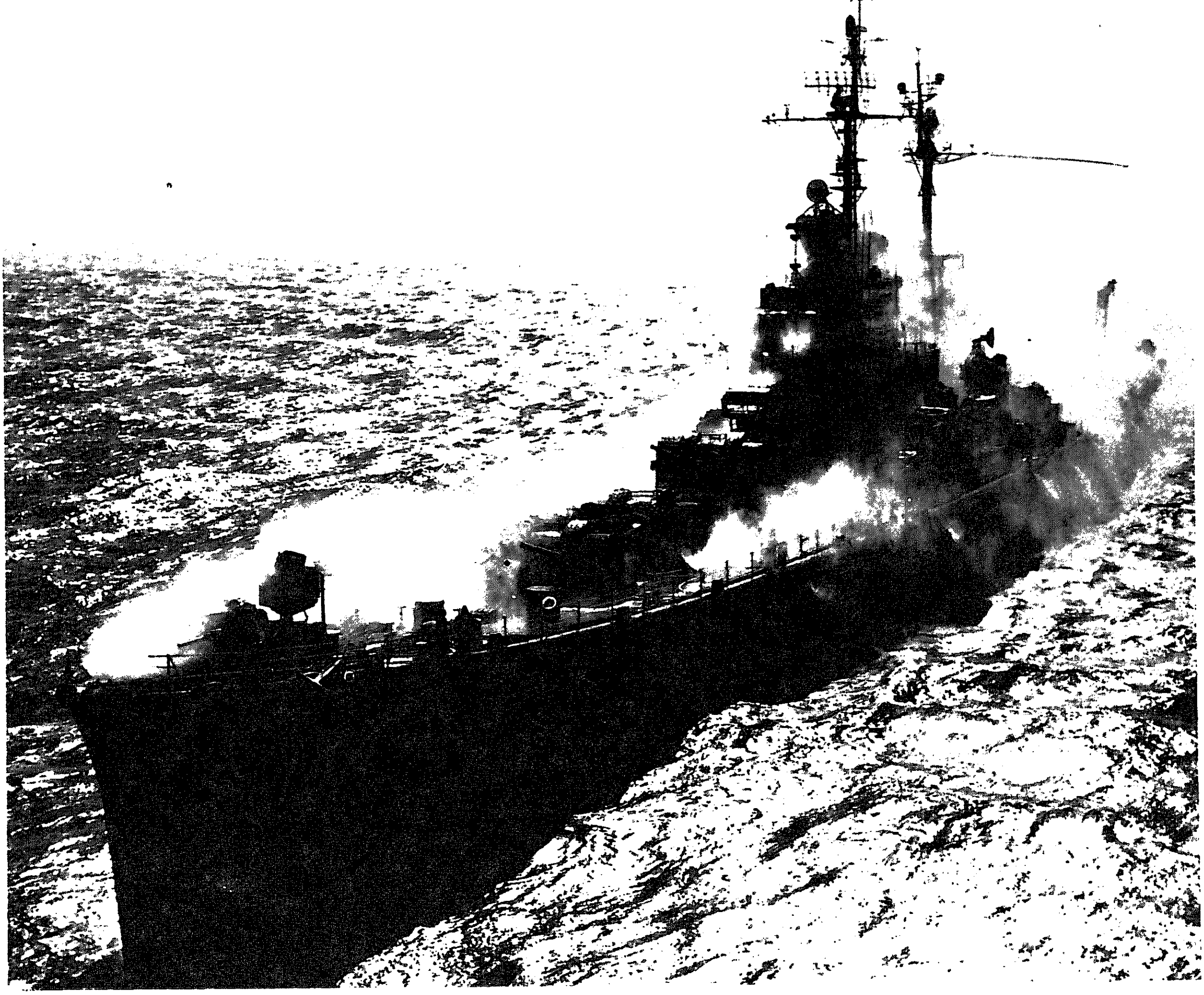

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Figure 7-72.—Water washdown system in action.

Ships without washdown systems will initially decontaminate by hosing down with seawater as soon as the tactical situation permits.

BIOLOGICAL DECONTAMINATION

The shipboard methods available for biological decontamination include flushing, scrubbing, and heating. Sterilizing gases and disinfectant vapors are used in industrial decontamination, but they are not currently recommended for shipboard use. The method to be used in any particular case depends upon the nature of the area or equipment to be decontaminated.

For the ship's exterior surfaces, the water washdown system (together with hosing down) will be the most effective countermeasure available. After washdown and hosing, thorough scrubbing or swabbing with approved compounds will decontaminate any remaining biological agents.

The procedure for hosing down exterior surfaces to remove biological contamination is as follows:

1. Work from top to bottom, from the windward side to the lee side, and from forward to aft.
2. Be sure the firemain pressure is at least 80 psi.

Hold the hose at a 30-degree to 40-degree so that the water will hit the deck 15 to 20 way from the nozzle. Use a solid stream.

Overlap the hosed areas to provide a lete washdown.

Control the drain-off.

quid disinfectants or decontaminants are ive for decontamination of the ship's interior s. The main problem in the use of these ials is that it is difficult to reach all minated surfaces with the liquid to obtain ate contact between the liquid and the genic organisms. To overcome this problem, hould usually apply liquid disinfectants or taminants to all surfaces with a coarse spray e or with swabs until the surfaces are letely wet. All accessible surfaces are then d or scrubbed with swabs or brushes to bring rganisms and the liquid into close contact. this treatment, the compartment is closed prescribed period. Operating personnel d be equipped with masks and protective ng, as protection against the decontaminant ll as against the organisms.

f the several liquid decontaminants that have d effective against biological agents, the only generally available for shipboard use is um hypochlorite. (NOTE: Calcium chlorite and oil form an explosive hazard, care must be exercised when it is used.) A on of 0.3 percent calcium hypochlorite is This solution is more effective if 0.5 nt detergent (called DECONTAMINATING POUND) is added. If decontaminating ound is not available, laundry detergents be added to increase the effectiveness of the um hypochlorite solution. If calcium chlorite is not available, various other rials available aboard ship can be used for tamination. These materials include laundry gents, soaps, dishwashing compounds, and compound.

alcium hypochlorite is a powerful oxidizing , and it is highly corrosive. The corrosiveness ases as the temperature goes up. Calcium chlorite should NOT be used in conjunction steam when the compartment contains ate or critical electronic or electrical ment. Also, calcium hypochlorite should not ed on aircraft, weapons material, navigation ments, or similar gear because of the bility of corroding exterior surfaces or ealed parts.

In using calcium hypochlorite or other cleaning agents for biological decontamination, start at the highest point and work downward. Change the wiping cloths, swabs, and scrub brushes and dispose of waste at frequent intervals.

Steaming is an effective method of decontamination for the ship's interior spaces. A sufficient amount of steam should be admitted to the compartment so that all air will be displaced. This allows the compartment surface to be heated rapidly to the maximum temperature of approximately 212 °F; at this temperature, most germs are killed in about 15 minutes.

CHEMICAL DECONTAMINATION

The major problem in chemical decontamination is to decontaminate successfully after an attack by any of the blister or nerve agents. The general methods used for decontamination include natural weathering, chemical action, the use of heat, the use of sealing, and physical removal.

Natural weathering relies on the effects of sun, wind, and rain to dissipate, evaporate, or decompose toxic chemical agents. Weathering is by far the simplest and most widely applicable method of chemical decontamination; in some instances, it offers the only practicable means of neutralizing the effects of chemical agents, particularly where large areas are contaminated.

Decontamination by chemical action involves a chemical reaction between the chemical agent and the chemical decontaminant. The reaction usually results in the formation of a harmless new compound or a compound that can be removed more easily than the original agent. Calcium hypochlorite is the chemical decontaminant usually used aboard ship for both chemical decontamination and for biological decontamination.

Expendable objects or objects of little value may be burned if they become contaminated. This procedure should not be used except as an emergency measure or as a means of disposing of material that has been highly contaminated. If this method is used, a very hot fire must be used. Intense heat is required for the destruction of toxic chemicals. Moderate or low heat may serve only to volatilize the agent and spread it in aerosol form. When a large amount of highly contaminated material is being burned, downwind areas may contain a dangerous concentration of toxic vapors. Personnel should be kept away from such areas.

Steam may be used for decontamination of chemical agents in interior compartments of the ship. The steam hydrolyzes and evaporates chemical agents and flushes them away from the surface. The effectiveness of the steam increases with temperature—the hotter the steam, the faster the neutralizing action. The procedure for steaming a compartment to decontaminate chemical agents is as follows:

1. Introduce steam at 30 to 50 psi, using the air test fittings of other outlets.
2. Be sure that the compartment is entirely secured except for an exhaust line. The exhaust line should be led to topside.
3. If possible, check the exhaust temperature. When the exhaust temperature is about 200°F, reduce the pressure to 20 psi. If it is not feasible to check the exhaust temperature, assume that it is high enough after 15 minutes of steaming; then reduce the steam pressure to 20 psi.
4. Continue steaming for one-half hour or longer, depending upon the size of the compartment and the degree of contamination.
5. Check the exhaust periodically with a detector kit for residual traces of contamination.
6. After the steaming, clean the compartment thoroughly.

Although steam is not corrosive, quick acting, or readily available aboard ship, it does have some disadvantages that should be noted. For one thing, it should NEVER be used to decontaminate lewisite (L), since another poisonous compound may result. Also, the high temperatures necessary for steam decontamination could result in damage to some compartments and to certain types of gear. The moisture content of steam may also be damaging to some equipment.

In some cases, you may accomplish chemical decontamination by sealing off porous surfaces to prevent the absorption of chemical agents or to prevent the volatilization of agents already on the surfaces. Sodium silicate, commonly called water glass, is the substance that is commonly used for sealing porous surfaces. Sodium silicate is applied with a brush. After some exposure to air, it forms a hard, transparent coating. Several applications are required to completely seal a surface. Although it might seem that paints and varnishes could be used to seal off surfaces, they must NOT be used for this purpose because they are readily penetrated by most blister agents. In fact, they form solutions of blister agents.

You can also effect chemical decontamination by physically removing the toxic agents from the contaminated surfaces. You can do this by washing or flushing the surface with water, steam or various solvents.

Decontamination by flushing with water can be accomplished with the water washdown system or by hosing. The procedures are similar to the procedures for flushing away biological agents. However, the use of water for chemical decontamination has some disadvantages that should be noted. Water, like steam, must not be used for lewisite decontamination because of the poisonous residue that may be left. Also, flushing with water is not effective against blister gases unless it is employed immediately after exposure to the blister agents, before the agents penetrate any surfaces. The use of water may also result in the release of nonpoisonous but highly corrosive acids. Because of these considerations, it is necessary to make sure that all surfaces are washed THOROUGHLY and that no reaction products remain when water is used for chemical decontamination. When water is used, remember that hot water is much more effective than cold water for chemical decontamination. Also, remember that the effectiveness of water may be increased by the addition of soaps or detergents.

Solvents other than water are sometimes used to dissolve chemical agents so that they may be readily removed. Such solvents include gasoline, oils, alcohol, antifreezes, dry-cleaning solvents, and so forth. All solvents must be used in accordance with appropriate safety precautions.

Alkaline solutions destroy G-agents by hydrolysis. Alkaline solutions that may be used include lye, washing soda, ammonia, and baking soda. The stronger alkali solutions are more effective than the weaker ones.

Decontamination should be started as soon as possible after chemical attack. The priorities for decontamination vary, depending upon the type of ship and other factors. In general, something similar to the following sequence of decontamination is likely to be used:

1. Weapons equipment
2. Navigation equipment
3. Vital topside areas such as gun mounts, the bridge, lookout stations, and areas that must necessarily be occupied by personnel
4. Vital machinery spaces
5. Topside areas from which the contamination could be spread to the interior of the ship
6. Interior compartments
7. All other areas

CHAPTER 8

FUNDAMENTALS OF NAVAL WEAPON SYSTEMS

This chapter is allocated to naval warfare. Its purpose is to enable merchant marine officers to understand the threat they would face at sea in a hostile environment and to understand how naval forces operate to protect merchant ships at sea.

Naval warfare is a conflict in which at least one of the opponents is operating from the sea with surface ships, submarines, or sea-based aircraft. The three naval warfare areas are surface, submarine, and air. Each of these areas has its operating characteristics derived from the nature of the operating medium, and each has its own particular strengths and limitations. The art of naval warfare is to employ surface, submarine, and air forces to exploit the strengths and minimize the weaknesses of each. This objective has led to the integrated operation of surface, submarine, and air forces operating together in mutual support, with the common objective of gaining advantage over the enemy by enhancement of offensive capabilities and decreasing individual vulnerabilities. Naval forces now and in the future must be structured to integrate all three warfare areas in the prosecution of their tasks to meet a similarly multidimensional threat.

NAVAL WARFARE TASKS

The Navy's functions include both sea control and power projection. Therefore, naval warfare tasks must address the accomplishment of the Navy's functions through the three areas of surface, submarine, and air warfare against the opposition of similarly delineated forces. The resulting warfare tasks are classified as fundamental tasks and supporting tasks.

FUNDAMENTAL WARFARE TASKS

The fundamental warfare tasks are as follows:

1. Antiair warfare (AAW). The destruction of enemy air platforms and airborne weapons, whether launched from air, surface, subsurfac or land platforms. AAW comprises all t measures that are employed in achieving a superiority.

2. Antisubmarine warfare (ASW). The d struction or neutralization of enemy submarine The aim of ASW is to deny the enemy t effective use of his submarines.

3. Antisurface ship warfare (ASUW). T destruction or neutralization of enemy surfa combatants and merchant ships. Its aim is to de the enemy the effective use of his surface warshi and cargo carrying capacity.

4. Strike warfare. The destruction or neutr ization of enemy targets ashore through the u of conventional or nuclear weapons. This incluc but is not limited to: targets assigned to strateg nuclear forces, building yards, and operati bases from which an enemy is capable of condu ing or supporting air, surface, or subsurfa operations against U.S. or allied forces.

5. Amphibious warfare. Attacks, launch from the sea by naval forces and by landing forc embarked in ships or craft, designed to achie a landing on a hostile shore. It includes f support of troops in contact with enemy forc through the use of close air support or sho bombardment.

6. Mine warfare. The use of mines and mi countermeasures. It consists of the control denial of sea or harbor areas through the layi of mine fields and countering enemy mi warfare through the destruction or neutralizati of hostile mine fields.

All of these fundamental tasks, with t exception of antisurface ship warfare and stri warfare, are applicable to merchant ship ope tions in wartime and are discussed in detail in t book.

SUPPORTING WARFARE TASKS

The supporting warfare tasks are as follows:

1. Special warfare—This involves naval operations that is generally accepted as being nonconventional in nature, and in many cases, clandestine in character. Special warfare, which often accomplishes fundamental warfare tasks, includes special mobile operations, unconventional warfare, coastal reconnaissance, and certain technical intelligence operations.

2. Ocean surveillance—Ocean surveillance is the systematic observation of ocean areas to detect, locate, and classify selected high interest aerospace, surface, and subsurface targets and provide this information to users in a timely manner. A target may be any hostile, neutral, or friendly platform of interest. Ocean surveillance provides the current operational setting in which Navy commanders deploy forces to do battle. Ocean surveillance both supports and depends upon C^3 (command and control and communications) and intelligence, and, therefore, must be integrated with both.

3. Intelligence—Intelligence is the assessment and management of information obtained via surveillance, reconnaissance, and other means to produce timely indications and warning, location, identification, intentions, technical capabilities, and tactics of potential enemies and other countries of interest. Current and complete intelligence, correctly interpreted according to the task at hand, permits military decisions to be based on accurate knowledge of the enemy's forces and capabilities.

4. Command and control and communications (C^3)—The overall operational management of the Navy in peace and war. The Navy Command and Control System (NCCS) provides the means to exercise effectively the authority and direction of naval forces in the accomplishment of their mission. The objectives of the NCCS are to ensure that the National Command Authorities (NCA), unified commanders, naval component commanders, and subordinate naval commanders are able to discharge their individual responsibilities by receiving sufficient, accurate, and timely information on which to base their decisions and by having available the means to communicate these decisions to the forces involved. Effective control over its forces allows the Navy to operate on a coordinated basis in fulfilling its worldwide operational responsibilities.

5. Electronic warfare—The electronic support for all warfare tasks. Its primary objective is to ensure effective use of the electromagnetic spectrum by friendly forces while determining, exploiting, reducing, or denying its use by an enemy. Electronic warfare assists in the detection and targeting of hostile forces while making it more difficult for the enemy to detect and target friendly forces.

6. Logistics—The resupply of combat consumables to combatant forces in the theatre of operations. It may often be a major factor in determining the success or failure of an operation. A principal aim of naval logistics is to make the operating forces as independent as possible of overseas bases. Most movement of supporting supplies to engaged U.S. naval forces and to all other U.S. combatant and allied forces is by sealift. U.S. maritime mobility forces are composed primarily of ships of the Military Sealift Command, various ships held in reserve for defense employment, and ships provided from the U.S. merchant marine.

The use of U.S. maritime mobility forces for logistic support was outlined in chapter 4. Of the remaining supporting warfare tasks, only electronic warfare is relevant to the scope of this text.

All of the fundamental warfare tasks are accomplished through the use of various weapon systems and are coordinated on individual ships in the combat information center (CIC). Therefore, before the individual warfare tasks are discussed, it is necessary to become familiar with the operation of CIC and the fundamentals of naval weapon systems.

WEAPON SYSTEM CONCEPT

Fire control is problem solving, the problem of destroying a target with ship's armament. Solutions must be found for the three types of targets: surface, air, and underwater targets. The effective use of any weapon system requires that a destructive device be delivered to a target. The destructive device (weapon) could be a guided missile, gun projectile, rocket, torpedo, or depth charge.

To deliver the weapon accurately, we must know both the location and the velocity of the target. Many air targets now travel faster than sound and must be engaged at great distances. A weapon is most effective when it is used as part of a ship's weapon system against such targets.

A weapon system is the combination of weapons, each classified by its tactical purpose, and the fire control equipment used with each weapon or multiple of weapons to damage or destroy a selected target.

A weapon system includes the following:

1. Units that detect, locate, and identify the target
2. Units that direct or aim a delivery unit
3. Units that deliver or initiate delivery of the weapon to the target
4. Units termed weapons that destroy the target when in contact with it or near it

Figure 8-1 represents a typical shipboard weapon system. The equipments making up each of the four categories of functional components are enclosed in separate blocks. The following headings take up the purpose of the four groups and introduce some of the equipment used to solve the fire control problem.

WEAPON SYSTEM REQUIREMENTS

The Navy has a rather elaborate series of stages through which any weapon or associated item must go from the time it is proposed until the solid hardware itself is installed for service use aboard ship. Although the fundamental idea on which the item is based may originate almost anywhere (ideas are welcome regardless of the source), it is the Chief of Naval Operations, speaking for the ultimate user, the fleet, who sets the requirements that the weapon (or whatever it is) must meet. The prototype (first installed model) of any instrument or piece of equipment which bears a Navy nameplate that you see on a naval vessel has been through exhaustive engineering and shipboard application tests, and meets the fleet's requirements for what that specific item must do, and how well it must do it.

The trend in recent times has been increasingly toward design and procurement of complete weapon systems, rather than of component units which later evolve into a system (like most systems based on guns). This is especially true of newer systems, such as missiles with their complex guidance and propulsion systems.

The statement of requirements for any weapon system or component unit can be considered as responses to two questions:

2. How well is the system or compone unit supposed to do it?

The answer to the *what* question is oft called the *military requirements*. Military requi ments is a statement of the nature of t equipment and its capabilities, such as t following examples:

1. If it's a gun, its range, rate of fire
2. If it's a torpedo, its speed, range, a curacy, sensitivity
3. If it's a radar, its range, accuracy, sen tivity
4. If it's a computer, its speed, accuracy solution, limits of operation

Obviously all this is entirely dependent on t nature of the system or component un Moreover, in a system, each component's requi ments depend on the characteristics of the oth components and on the requirements of t system as a whole. Thus, the capabilities of a system are limited by those of the "weakest lin in the system. (For example, a computer in ASW system can solve fire control proble beyond the ranges possible to the sonar equipme in the system; the sonar's range therefo establishes the system's range.)

Aside from what we have called the milita requirements, which depend on the nature a task assigned to weapon systems and weap system components, there are some requireme that are generally applicable to all, regardless the nature of the system or component. These c be considered as the answer to No. 2 above. V can state them here only in qualitative terms sin this is a general discussion; in system specific tions these requirements are reduced to speci values as follows:

1. RELIABILITY. The system must capable of continuous long-period functioni under specified adverse conditions at specific ra (for example, rounds per minute fired, or h maintained at specified accuracy).

2. FLEXIBILITY. The system must capable of functioning satisfactorily in spite failures in quality of power supply, ammunitio and so on; it may also be required to functi satisfactorily with certain components omitted disabled, or with others substituted.

3. SAFETY. The system perhaps does n

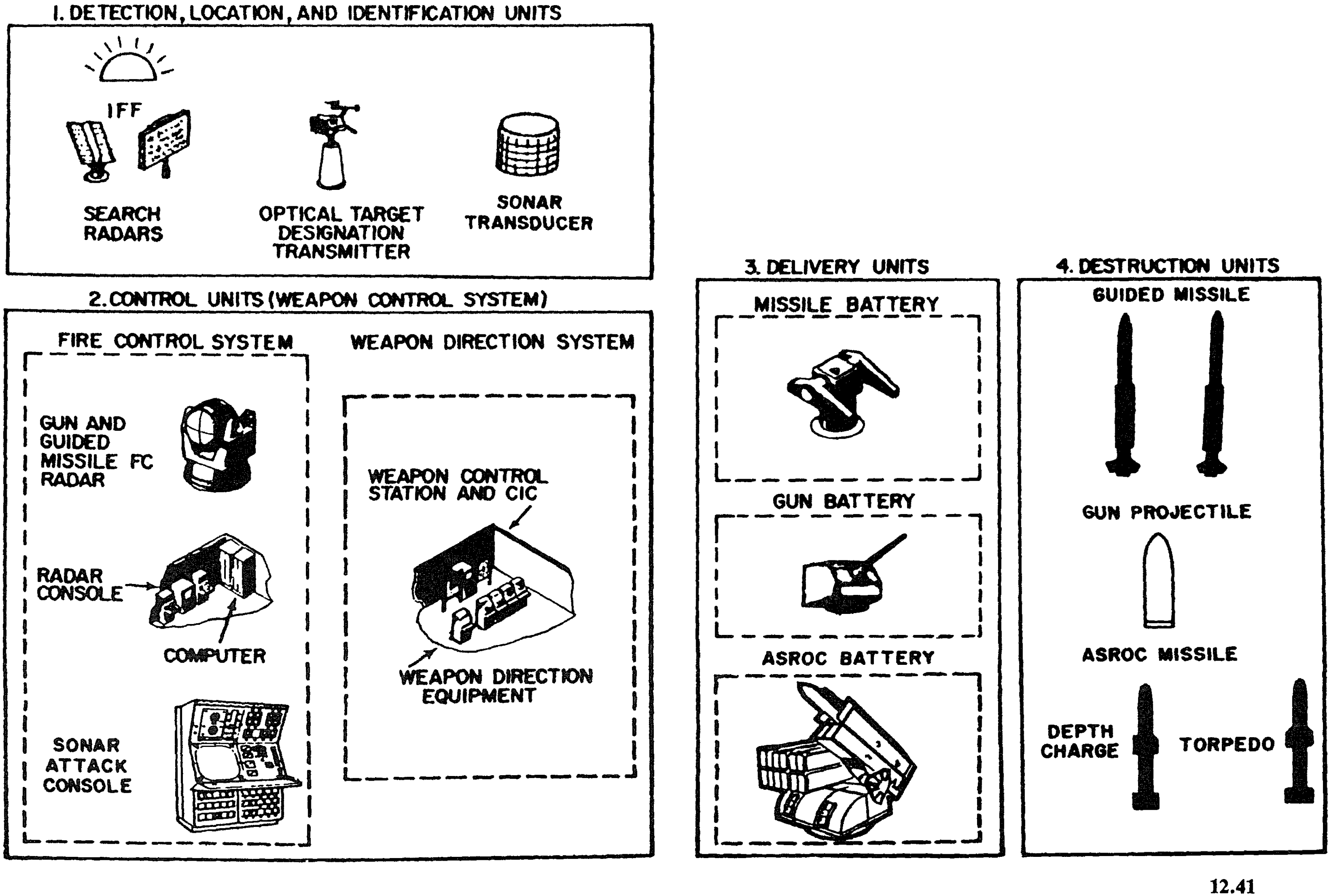


Figure 8-1.—Weapons system concept.

aircraft or own-ship structure or personnel.

4. SIMPLICITY OF OPERATION. Complex modern weapon systems cannot be made inherently simple, but they should be designed for facility of operation by human beings. These considerations influence design of control arrangements, provisions for safety and comfort of operating personnel, and functional design to make the equipment as simple to operate as its nature will permit.

5. MAINTAINABILITY. This requires not only design using long-life components but also convenient (and in many cases almost entirely automatic) testing and trouble-diagnosing gear that is either part of or is easily connected to the equipment. Moreover, this requirement has led to the development of the unit replacement principle. Thus, if an amplifier, for example, burns out, the procedure is not to test each component in it and make repairs as necessary, but to pull out the whole amplifier (which is a complete plug-in unit) and plug in a replacement. The defective unit can then be repaired later and put back in stock as a spare.

Note that in weapon component or system design, these requirements often conflict with each other. For example, a fuzing system may be made so safe that it won't function reliably. Much of the work in weapon design is concerned with attaining practical compromises between conflicting requirements.

The evaluation of a weapon system or component unit can be defined as the study of the system or unit, measurement of its effects, and appraisal of its effectiveness. As in development of ordnance material, the trend is toward evaluation of complete systems rather than independent units; in system testing and evaluation, however, component units are tested individually as well as with relation to their systems. Before a system or component is accepted for fleet use, it must go through both TECHNICAL (that is, engineering) and TACTICAL evaluation, following standard prescribed procedures.

DETECTING UNITS

The first steps in the functioning of a weapon system are the detection, location, and identification of the target. Ideally, the detection unit should detect the presence of a target at maximum range, and establish the target's location, with maximum accuracy and minimum delay. A
the same time this device should identify the targ
as to exactly what it is and whether it is enem
or friendly. Ideally, the device should be equal
efficient regardless of which medium it operat
in, regardless of the conditions in that mediun
and regardless of interference originating with th
enemy, with friendly forces, or with natur
causes.

No detecting (for the present, let this ter
include locating and identifying) device or syste
yet developed measures up, without possibility o
improvement, to any of these ideals. The idea
are useful chiefly as standards by which th
effectiveness of detecting devices can be judge
The principal detecting devices now used in th
fleet include the following:

1. Optics
2. Radar
3. EW (electronic warfare)
4. Sonar
5. MAD (magnetic anomaly detection)

All except the last of these depend o
detection of radiation—the first three on electro
magnetic radiation, the fourth on sound radi
tion. MAD depends on detecting differences i
magnetic fields.

Optics are invariably passive; that is, the
detect radiation emitted or reflected by the targe
but they don't produce the radiation they detec

EW equipment falls into the passive catego
when used for detection and active when used f
jamming the enemy's electronic detection equi
ment. Sonar may be either passive or active whe
detecting subsurface targets. Its active devi
produces radiation, which it detects as a reflectio
from the target. For passive sonar to detect
target, it has to receive noise from the targe
Radar can only be active.

Optics

Optical devices in weapon systems function t
establish target bearing and (for air targets) targ
elevation. Some optical devices can measure th
range to the target. Except for highly unusu
atmospheric conditions in which light ray
reflected from the target to own ship a
perceptibly bent by refraction, the line of sig
(a straight line from target to observer) is tru
straight. Optical devices that incorporate le
systems are designed to magnify the image of th

ırget; this extends the capabilities of the human ye in target detection and identification.

Since optical devices depend on visible light :flected from the target, they are handicapped y darkness (unless the target is luminous), fog, ıd visible obstacles. Optical devices are always ıssive (that is, they never provide the light that akes the target visible), but an attacking ship ın illuminate a target by firing gun projectiles ıat release parachute-supported flares in the cinity of the target or by using aircraft to drop ıch flares.

At the present time, only a few U.S. Navy ıips have night observation devices; but entually, most Navy ships will have these. Night ›servation devices actually intensify the ightness of an image and are used for observa- ›n, surveillance, and for the aiming of weapons ıring night operations. They use natural light diations of a very low level to produce a useful, ;ible image.

Since light in general travels in straight lines, target cannot be optically detected if it is tirely below the horizon (like target 2 in fig. 2).

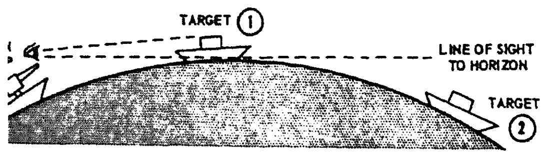
ıdar

In our short discussion of radar, we will ncentrate on its ability to measure the range or ;tance to a target. Navy radars can measure the get's angle of elevation above the surface rizontal, its altitude, and its true or relative aring. This is, of course, if they are designed do so. The target's speed can also be quickly termined if we add some minor computing its. In chapter 10 you will learn more about how lar works, but for now let's find out how it asures range.

Every naval ship is equipped with a powerful ınd producer—its whistle. Suppose that the istle on your ship sounds a short, sharp blast ile it is a mile or two distant from another ship. 'ou listen carefully after the blast sounds, you will hear an echo reflected from the other ship. If you know the speed of sound and can measure accurately with a stopwatch the time elapsed between the whistle blast and the echo, you can easily determine the range to the other ship. This is a simple application of the distance, rate, and time equation which you probably learned years ago. You'll notice one slight variation however; the product of rate and time must be divided in half to account for the two-way travel of the sound wave.

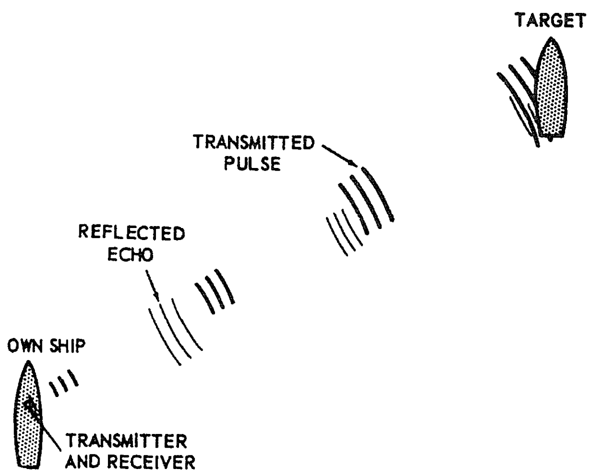
If instead of a sound producer you use a powerful radio transmitter, and instead of your ears you use a radio receiver, you have the essentials of radar. (The name *radar* is an acronym for RAdio Detection And Ranging.) Figure 8-3 shows one transmitted pulse and one reflected echo as they travel between own ship and the target. Notice that the transmitted pulse covers a larger area in space as it gets farther away from own ship. The amount of this increase depends on many variables, one of which is the type of transmitting antenna used. Notice also that the reflected echo is smaller in amplitude since only a portion of the transmitted energy is reflected by the target. Further, the echo expands as it approaches own ship, and only a portion is actually received by the receiver.

To be of any use, the reflected echo must be greatly amplified in the radar receiver before it can be displayed on the cathode-ray tube. The cathode-ray tube (similar to a TV picture tube) provides a visible display, which can indicate target range, bearing, and/or elevation. The



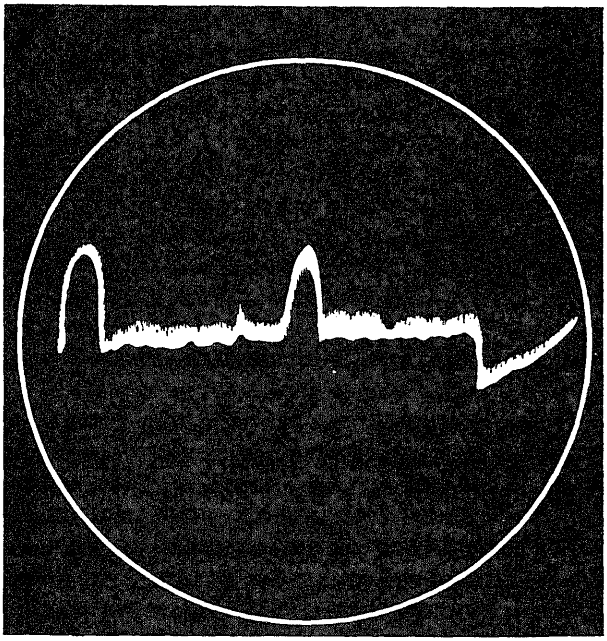
110.1

Figure 8-2.—Limits of optical detection.



110.2

Figure 8-3.—Principle of radar.



110.3

Figure 8-4.—A common type of radar display.

display in figure 8-4 is designed to provide range information only, and it could be the results of the situation in figure 8-3. The vertical "pip" or "blip" at the left of the sweep trace in figure 8-4 represents the transmitted pulse; the center pip is the target echo. The sawtooth shape at the right of the display is the range measuring device, which is called the "range step" in this case. You will see in a moment how the range step is moved to the echo to measure range; but, first, let's learn a little more about the sweep trace.

Even though the display appears to be continuously illuminated, it is in fact caused by a pencil-point beam of electrons, which are made to "sweep" across the face of the scope from left to right. The sweep frequency is the same as the pulse repetition frequency of the radar. In layman language this simply means that every time a transmitted pulse leaves the antenna, a sweep is started. Actually, the sweep starts just a little earlier so the transmitted pulse can be viewed. The apparently continuous picture is the result of a property of the scope face called persistency, which means that a given point on the scope face continues to give off light for a short time after the beam of electrons has passed it. You have seen this effect when you turned off a television set and watched the illumination slowly fade.

The transmitted pulse, echo, and range step are traced by bending the beam of electrons above and below the vertical center of the scope, which is the normal vertical position of the sweep trace. Vertical deflecting plates or vertical deflecting coils are used for this purpose. In our example, the transmitted pulse must have been applied to the vertical deflecting plates before the reflected echo, and the echo was applied before the range step. This is how the stopwatch is replaced. The designers simply arrange the scope so that a given portion of the sweep trace equals a certain number of yards (in some cases, miles). Then we can measure the trace distance, which is based on time, between the transmitted pulse and the echo. The sweep is made to move from left to right on the scope by horizontal deflecting plates or coils. The sweep movement is linear. It is based on time, and it is accurately matched to the range measuring circuitry.

In the preceding paragraph we mentioned based on time; let's explore this a bit further. The speed at which radar energy travels is 186,000 miles per second or 300 million meters per second—the speed of light. Because of this great speed, the time elapsed between transmitting and then receiving an echo is measured in microseconds (millionths of a second, or μsecs). Obviously, a stopwatch will not do the job. As you have seen, a cathode-ray tube is used instead. With the speed of light as the reference, we find that radar energy travels 328 yards in 1 μsec. From this we can say that 1 nautical mile (about 2,000 yards) will be traversed by the energy in 6.1 μsecs. This is the time standard upon which most radars, and certainly most fire control radars, have been designed. Once again, it takes 6.1 μsecs for the energy to travel approximately 2,000 yards. These 6.1 μsecs represent 1,000 yards of RADAR RANGE.

Now let's measure the range to the target. A range counter is attached by mechanical linkage to a range hand crank or to a range drive motor, which drives the mechanical linkage. Moving the mechanical linkage by either method moves the counter and positions the range step to the corresponding position on the sweep. All the operator has to do to measure range is position the range step under the target echo and read the range from the counter. Moving the range linkage changes the time relationship between the transmitted pulse and the range step, and therefore controls the horizontal position of the range step on the sweep. If the range step were under the transmitted pulse, the range counter

would read approximately zero yards. It would increase as the range step moves from left to right across the sweep in response to the operator's input.

Radar transmission is made from a metal structure called an antenna. Unlike the sound from a ship's whistle, which radiates almost equally in all directions, most of the energy in a radar pulse is directed along the bearing on which the antenna is pointed at the instant of transmission. The same antenna also picks up the echo. To get 360° coverage, radar antennas rotate continuously; antennas on radars designed to concentrate on a narrow angular sector are instead aimed by an operator. In addition, many of the latter type scan either mechanically or electronically through a small angle.

Radar signals are conducted to and from the antenna by transmission lines. These transmission lines are in the form of waveguides or coaxial cables. The waveguides vary in shape from circular or elliptical to rectangular with the physical size dependent on the frequency the radar uses.

Radar shares many of the characteristics of optical detecting devices. Except for certain atmospheric conditions which to a minor extent distort the paths of the transmitted and reflected pulses, they travel in straight lines. As compared with a sound-ranging system like the one mentioned briefly by way of example at the beginning of this article, radar has much more range, functions several thousand times more quickly and much more accurately, and is not affected by audible noise. It is quite accurate in measuring target bearing and elevation. It is the most accurate and the longest in range of our range-measurement devices. It is not severely affected by adverse weather and fog, is just as usable at night as in the daytime, and is virtually immune to static and electromagnetic disturbances that plague communications, radio, and television. Also, its signals can be used to guide missiles or to guide target-tracking equipment.

But radar has disadvantages too. It can be jammed or interfered with by enemy radar transmissions and other countermeasures. It does not permit easy identification by target silhouette or other visible characteristics; it shows only a blip for a target, and it may show but one blip for several targets. As compared with optical methods, it requires skills in interpretation of its displays amounting almost to an art. Its complex electronic circuitry, waveguide plumbing, and mechanical rotating and nutating gear require constant maintenance. As is true of any revolutionary technical advance that is depended on heavily, its loss through malfunction or battle damage is an especially severe handicap. Lastly, radar pulses can be detected by the enemy at much greater ranges than those at which the pulses will reveal to the originating ship the enemy's presence. As the discussion later of EW will indicate, radar pulses are a telltale that may reveal a great deal of other information to the enemy also.

In spite of these disadvantages, radar is the primary means of detection used in the fleet today.

EW (Electronic Warfare)

EW has been defined as the means by which your own forces attempt to nullify advantages of enemy electronic devices and to obtain all possible information concerning enemy electromagnetic radiation. EW may be either passive (ESM) or active (ECM).

ESM (electronic support measures) are measures not detectable by the enemy. The most important is intercept search by sensitive receiving equipment. Intercept search will detect electromagnetic radiations from any kind of electronic equipment the enemy might use—radars, radios, electronic controlled weapons, and electronic navigational aids. It will show the direction from which the radiation is coming and display and record the radiation so that it can be analyzed. From such analysis, information can be determined, such as the type of equipment radiating, what its function may be, and the number of transmitters involved. Think of ESM as a kind of passive radar.

Other ESM methods are tactical evasion (to avoid detection by the enemy) and control of electromagnetic radiation by own ship (that is, silence imposed on own ship's electronic transmitters) to avoid telltale radiation detectable by enemy EW gear.

ECM (electronic countermeasures) include those methods which the enemy can detect. In fact, its purpose is to impair the operation of the enemy's electronic devices (such as radar) by feeding them false signals. One method is jamming—radiating an interferer or deceptive signal by electronic transmitters. The other is deception—using electronic and mechanical reflecting material to mislead his radars.

ECCM (electronic counter-countermeasures) involves the action taken to ensure effective

friendly use of the electromagnetic frequency spectrum despite the enemy's use of EW.

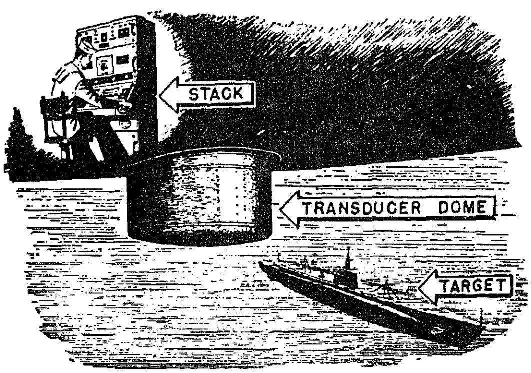
EW does not have as important a role in weapon systems as optical devices, radar, and sonar do. Weapon systems can incorporate ECM; there are gun and rocket projectiles designed to scatter radar-reflecting materials. ESM may be used for direct guidance of weapon systems. The most common present naval application of ESM is the use of intercept search in preliminary guidance of weapon system detecting equipment. Other ESM methods are used to prevent enemy interference with weapon system functioning.

Sonar

Radar cannot be used under water because water absorbs radio waves. But water does conduct sound, better than air does, in fact. And sound is what the Navy uses to detect underwater targets.

It is possible to detect a submarine operating under power by merely listening with the aid of a suitable microphone. But present-day submarine detection equipment more often functions somewhat like radar—it emits a pulse of sound energy, then picks up echoes. The equipment is called SONAR—SOund NAvigation and Ranging—and it not only detects underwater targets, but it also locates them in terms of range, bearing, and depth.

The main units of the sonar equipment (fig. 8-5) are a transducer housed in a water-filled dome (a streamlined housing protruding from the ship's hull) and console (STACK), manned by a sonarman. The stack periodically produces a powerful pulse of alternating current that is transmitted to the transducer. The transducer converts the current into a pulse of high-frequency sound (around 5,000 hertz—1 hertz = 1 cycle per second) and projects it into the water. The transducer then switches to receive echoes, which are amplified in the stack. However, sound vibrations of 5,000 hertz (Hz) are too high in pitch to be audible to people of normal hearing. Consequently, the stack's electronic circuits convert the echo to an easily audible 800-hertz note which the sonarman hears over the stack's loudspeaker. A visual indicator presents an image of sonar echoes as blips on the face of a cathode-ray tube (much as with radar). Additional sonar equipment determines the depth of the target.



53.117

Sonar is most frequently active; that is, an ultrasonic sound pulse is transmitted and the echo detected as described above. However, the sonar transducer can also be used to pick up sounds in the water, such as the sound of a submarine's propellers beating the water, the sounds of machinery in the submarines hull, or sounds from subsurface animal life, such as whales grunting or squealing.

Sonar is the principal method now known for detecting underwater targets that are not themselves radiating sound signals. The principal factor limiting the success of antisubmarine warfare at this time is the limitations of sonar equipment. Although sonar is in some ways analogous to radar in the principle of its operation, it is more limited in range, less accurate in establishing target bearing and range, more severely affected by environmental factors such as variations in water temperature and flow at various depths, and is much more responsive to spurious echoes (as from schools of fish, wakes, air bubbles released by the target, and from the ocean floor or surface). Sonar echo interpretation (using both audible and visual responses) is exacting and requires much skill and experience.

Sonobuoys are used in one application of passive sonar. They are floating unmanned radio transmitters, which lower microphones into the water and broadcast the sounds that they pick up. Sonobuoys are generally dropped by ASW aircraft. Analysis of the sound pattern broadcast from several of them will indicate the location of sound-radiating submarines in the vicinity.

Sonar gear is carried aboard surface vessels and submarines. A special adaptation called

wered by cable from a helicopter, is used to lement surface ASW forces.

) (Magnetic Anomaly Detection)

ıny ferrous object will distort the earth's ıetic field. This distortion can be detected by ısitive device—magnetic anomaly detection D) equipment—that can either be towed by p or carried in an aircraft. At present, MAD is even more limited in range than sonar. Its ciple of operation is applied also in guidance ome weapons.

TROL UNITS

Control units in a weapon system develop, oute, relay, and introduce data into a delivery a weapon, or both. They direct, control, or the weapon (destructive device) to the target, cause it to function in the desired way. These form the heart of the weapon system.

s of Control Units

DATA TRANSMISSION SYSTEMS send t position information developed by the cting units to the rest of the weapon system convey other data among the components of weapon system. Examples are synchro, ver, and potentiometer circuits.

COMPUTER DEVICES process the input from the detecting units and other sources out out the aiming and program instructions cause the weapon to reach its target. nples are rangekeepers and computers.

DISPLAY UNITS display information at us locations on the ship. These are generally ronic, electromechanical, or optical devices.

DIRECTING DEVICES with the aid of cting devices establish target location. cting devices can also function to directly or ectly control missile flight (examples are gun missile directors and radar sets).

EFERENCE DEVICES, such as stable ents, establish reference planes and lines to lize lines of fire, lines of sight, and other ences. These units usually are gyroscopically rolled.

IVERY UNITS

roadly speaking, delivery units launch or ect destructive units toward the target. nples of delivery units are guns, missile and rocket launchers, torpedo tubes, and depth charge projectors. Don't think of these devices as weapons. The term *WEAPON* is properly applied to the destructive unit that is launched or projected. Thus a guided missile launcher is not, strictly speaking, a weapon; the missile itself is the weapon.

All weapons must either be aimed at their targets or be programmed during flight to be effectively employed against their targets. They may require both aiming and programming. Programming is the process of setting automatic equipment to perform operations in a predetermined step-by-step manner. Aiming and programming are done at or before the time of launching, either by or through the delivery device. This function is characteristic of all delivery devices, even the simplest. Aiming the destructive device (weapon) at the target may be done simply by positioning the delivery device (for example, a gun barrel or launcher guide arm). Or it may be done without aiming the delivery device, by placing program instructions in the weapon. Some missiles are programmed to start searching for the target after the launching phase is over. Examples of other programmed functions that could be performed in the weapon are ignition of propulsion units and arming of the warhead after a designated number of seconds in flight.

Types of Delivery Devices

Many different types of delivery devices are available, such as guns, missile launchers, torpedo tubes, depth charges, and thrown weapon projectors, as well as rocket launchers. We will discuss only two—guns and missile launchers.

GUNS—Provide all the propulsion energy to their projectiles, direct (aim) the projectiles by positioning the gun barrels.

MISSILE LAUNCHERS—Retain and position missiles during the initial part of the launching phase and, by means of attachments to the launcher, feed steering, vertical reference, and program information into the missile up to the instant of launch.

DESTRUCTIVE UNITS

The end purpose of detection units, delivery units, and control units is to cause the destruction unit to intercept or pass near the target. It is then the function of the destruction unit to destroy or inflict maximum damage on the target. Except for projectiles used in small arms, and some of those

used in calibers up to 40 mm, weapons used in combat are loaded with explosives and equipped with devices to set off their explosion at the proper time. For some weapons, the proper time is the instant the weapon makes physical contact with the target. For those designed to penetrate targets protected by armor or concrete, the proper time is after penetration. Still others are intended to explode when they reach the vicinity of the target.

Basic Weapon Components

All weapons have the following components:

1. A CONTAINER or BODY that houses the internal components. The body may have such other functions as piercing armor, breaking up into high velocity fragments when the weapon explodes, or improving the weapon's ballistic characteristics by means of fins or streamlining.
2. A DETONATING DEVICE (called a fuze, exploder, detonator, and so on) which initiates explosion at the proper time, and includes safety devices to prevent premature explosion.
3. A PAYLOAD, which is the "reason for being" of the weapon. The payload usually consists of high-explosive or nuclear material.

Weapons of some types have their own propulsion systems. The outstanding examples are guided missiles, torpedoes, and rockets. With the exception of rockets, weapons that have a propulsion system also contain guidance and control systems.

FIRE CONTROL PROBLEM

In any weapon system the fire control problem is essentially that of getting the weapon or projectile to hit the target and explode, or at least to explode when the target and weapon or projectile approach close enough for maximum damaging effect. In gun weapon systems, the problem is to lay (aim) the gun so that the projectile will hit or approach close to the target. In some other types of weapon systems, the weapon is self-propelled and contains guidance equipment so that it is capable of homing on the target (that is, it can detect the target and follow it, ultimately catching up with it), or other guidance methods may be available. This is not true of gun weapon systems. Once the projectile has left the gun muzzle, nothing further can be done to affect its course. The gun's fire control problem must be solved before the gun fires.

VARIABLES IN THE FIRE CONTROL PROBLEM

To solve the fire control problem, it is necessary to consider the following three main types of variables:

1. Exterior ballistics. From the instant it leaves the weapons launcher until it ends its flight by impact or explosion, the delivery unit is affected by momentum, gravity, air resistance, and wind.
2. Target position and relative motion of the target and own ship.
3. Inherent corrections necessitated by the physical characteristics of the weapon system. These are the unavoidable miscellaneous factors, such as the rolling and pitching of the ship and parallax, which is the distance between fire control system elements located at different points aboard ship.

SOLVING THE FIRE CONTROL PROBLEM

In a given fire control system, some of the individual variables mentioned above may either be taken into account or neglected, depending chiefly upon target velocity (with respect to own ship) and range, and on desired accuracy and speed of solution. The main steps in solving the fire control problem are as follows:

1. MEASUREMENT of each of the variables to be taken into account.
2. COMPUTATION of what the delivery device position must be in relation to the line of sight from own ship to the target so that the destructive unit will hit the target. This information must then be transmitted to the gun mount missile launcher or other delivery device.
3. POSITIONING the delivery device in accordance with this information and energizing firing circuits are required.
4. OBSERVATION of effects of firing and correction of fire control information.

WEAPON SYSTEM TASKS AND OPERATIONAL PHASES

The overall task of any weapon system may be generally described as the delivery of a warhead

payload to a target area to ensure the maximum potential of the system. A basic analysis of task points up two major divisions or tasks that must be accomplished to attain the ired kill probability.

TASK	TASK
GET DEFINITION	WEAPON DELIVERY
OPERATIONAL PHASES	
GET DETECTION	WEAPON SELECTION
GET CLASSIFICATION	WEAPON LAUNCHING
GET LOCATION	WEAPON DIRECTION

The TARGET DETECTION PHASE involves surveillance of a known energy field and the ection or discrimination of any anomalies that ear within that field. For example, the energy d may be the field of electromagnetic radiation n the sun or earth's magnetic field, and ection would be achieved by visual or magnetic sors. The energy field can also be man-made—ight, by radar, or sound energy sources being ated either remotely or within the weapon em. In either case, suitable energy SENSORS needed both for surveillance and detection of malies in the energy field.

The TARGET CLASSIFICATION PHASE sists of classification of the detected anomaly identification of its source. Classification olves an analysis, perception, and definition he nature of the detected anomaly. Identifica- of the source determines its friendly or riendly character. For example, a sonar rator performs a surveillance of an active ustic field. When he sees a blip on the sonar play or hears an echo, he analyzes these signals etermine their source. By comparing the sound als received with the sonic signatures of known rces, he can classify the detected anomaly. If classification process indicates that the maly was caused by a submarine, the operator ntifies the character (friendly or unfriendly) of submarine by whatever means are available.

The TARGET LOCATION PHASE consists locating the target relative to the weapon ion with sufficient accuracy for effective apon employment and the maintenance of sor contact with the target for protracted periods. This phase requires the employment of sensors to maintain contact with the target and to sense information about its location and motion.

The WEAPON SELECTION PHASE involves selection of the optimum type of weapon, consistent with the mission of the weapon station and its capabilities, and the designation of a specific weapon system to destroy the target. For example, the captain of a destroyer may have depth charges and antisubmarine torpedoes available for employment against a submarine target. He will select the type of weapon (from those actually available and ready for use) that appears to have the highest kill probability under the prevailing conditions, and he will designate the related weapon system to destroy the target. When a guided missile cruiser detects a threatening air target, the weapon control officer will select either a beam riding or homing missile and designate a specific guided missile control system to the target with that type of missile.

The WEAPON LAUNCHING PHASE is concerned with the safe and efficient launching of a missile into the desired flight path. It involves also the assessment of target damage and the preparation for reattack.

The WEAPON DIRECTION PHASE consists of acquisition of the target by the designated weapon control system and the generation of the necessary weapon control orders to intercept the target. Acquisition requires that a sensor within the weapon control system acquire and lock on the target to gather information pertaining to target position and motion. This information is processed in the weapon control system to generate weapon control orders. The weapon control orders define the orientation of the missile velocity vector needed to destroy the target. This information is sent to the launching system for proper orientation of the launcher and the missile it contains.

In this phase, a target detecting sensor with an appropriate drive system is needed to continuously gather information about the target. A data processing system (computing system) is also required to transform the sensed target data into useful weapon control orders. In addition, a drive system is required for orientation of the launcher in response to weapon control orders.

CHAPTER 9

COMBAT INFORMATION CENTER

The development of radar by England and the United States (independently prior to World War II, then jointly) has been called one of the deciding factors in the Allied victory over the Axis forces. Radar has achieved even greater importance in the missile age. In the years since World War II, technological advances have resulted in more sophisticated and dependable radar equipment: three-dimensional systems, greater detection ranges, more reliable tracking capability, and so on.

Such equipment is relatively useless, however, without a means of taking full advantage of the information it supplies. Early in World War II, it became apparent that commanding officers could not personally sift all available information and extract the necessary data on which to base decisions since the inflow of information was too great. Additionally, combat reports emphasized the need for an up-to-date comprehensive surface and air picture. The lack of such information resulted in many tactical errors in the early months of the war. Consequently, in late 1942 a definite area was established aboard ship for the purpose of evaluating and correlating combat information. Known as the combat information center, this area was the forerunner of the present combat information center or CIC.

As the war progressed and experience was gained, CIC became more and more involved with providing assistance to command in combat operations, notably in air defense, shore bombardment, and antisubmarine operations. By war's end CIC was recognized as the combatant ship's nerve center. Today's CIC is no less important.

This chapter describes the duties of CIC and the basic organization necessary to accomplish its mission. Also provided are general capabilities of typical sensors, types of displays and their uses, internal communications, and an overview of the outgrowth of CIC, the naval tactical data system (NTDS).

MISSION AND FUNCTIONS

Simply put, CIC's mission is to keep command, higher authority, and control stations informed of the tactical situation at all times. To fulfill this requirement, CIC must be organized to efficiently perform its information handling functions of collecting, processing, displaying, evaluating, and disseminating data; exercising control, as delegated, of aircraft, weapons, own ship, and other craft. CIC must also assist command as required in such evolutions as search and rescue, navigation and piloting, man overboard, and tactical maneuvers.

COLLECTION

Although some people immediately think of radar in connection with CIC's function of collecting information, radar is only one source of data. Under some conditions of electronic silence, it plays no part at all. CIC may be likened to a clearinghouse that receives information from many sources, filters and evaluates it, and sends pertinent data to various stations in need of the information.

Basically, there are three categories of information sources: visual, electronic, and what can be termed "miscellaneous."

Visual Means

A prime source of visual information is the ship's lookouts. Not only are they often the only means of positively identifying a contact, sometimes they are the only means of detecting contacts that might escape radar detection; for example, low-flying aircraft, periscopes, or small craft.

Lookouts can also supply information concerning flight operations around nearby carriers, unusual activity aboard other ships, and sightings of objects in the water. Lookouts should be informed of all contacts detected by CIC so that they may be alerted to the appropriate direction.

Signalmen also provide visual information. In ition to relaying tactical signals, they augment lookouts as their duties permit.

tronic Means

Electronic means of detection include radar, ar, electronic countermeasures intercept pment, and radio. Radar equipments will be ussed later. Intercept equipment is not dis- ed because of its classification.

Sonar, while not a part of CIC equipment, ishes data concerning underwater contacts. 1 active and passive sonars are used. The e type transmits sound pulses; any returning es indicate a contact's bearing and range. ive sonars merely listen for sounds produced target. Active systems normally are associated surface ships, passive systems with sub- ines. However, ships and submarines can use 1 types of sonar.

CIC radio circuits are either radiotelephone ce radio) or teletype (TTY). Radiotelephone sed extensively for passing tactical and bat information between ships, and between e commanders and units under their control. teletype is used principally with the naval cal data system.

cellaneous Sources

Many documents are used as sources of rmation. These include intelligence reports, l warfare publications, operation plans and rs, aerological observations, radio messages, various instructions, notices, and directives. rmation is also received from other shipboard ons (for example, the status of weapons, pment, or launchers).

CESSING

All data received is processed to eliminate ssential information. This step consists of ng, inspecting, appraising, and correlating all rmation so that the resulting filtered infor- on may be displayed and disseminated as ssary.

PLAY

There are three types of displays: plots, status ds, and logs. Basically, plots show the egic and tactical situations; they consist of

Status boards display information primarily related to the tactical situation, but there are other types as well. Examples are the radiotelephone call sign board, communication status board, and gunfire support fire mission status board.

Logs provide a permanent record of a ship's operations and related information. Some logs are continuously maintained while underway, such as those for radio circuits. Others are kept only as required by the situation, such as the radar naviga- tion log.

Displays are further discussed later in this and succeeding chapters.

EVALUATION

Evaluation is the process of considering and weighing all available information to arrive at a decision that may be passed on as a recommendation to command and other stations as appropriate.

Factors taken into consideration include radar information, intelligence reports, operation plans, messages, and the current tactical or strategic situation. In addition, other factors blended with experience and common sense lead to a sound recommendation of a course of action or an estimate of probable tactical developments.

During normal steaming conditions, the CIC watch officer acts as the evaluator, with decisions limited mainly to routine matters; for example, a contact's location, course, speed, and closest point of approach, and recommendations to avoid if appropriate. During higher conditions of readiness, when increasingly greater experience is required, an evaluator is assigned. The evaluator may be the CIC officer, the operations officer, or the executive officer. Many ships now use a tactical action officer as the evaluator during Condition I.

DISSEMINATION

Carrying out the foregoing functions would be pointless if the information received stayed in CIC. Every station having a need to know must be supplied pertinent data: force/unit com- manders, flag plot, bridge, weapons control, lookouts, and so on.

How information is relayed depends on the type of ship. Voice radio and sound-powered telephones are common to all ships. Specialized communication links are common to a few; for

NTDS information via a teletype circuit (Link 14).

ORGANIZATION

For CIC to carry out its functions, it must have an organization that provides for all operations in which the ship normally might be engaged. The organization must also be flexible to meet any special requirements.

Figures 9-1 and 9-2 illustrate typical CIC enlisted personnel manning requirements for a representative conventional CG and an NTDS-equipped CG, respectively. Note billet number 13

CONDITION I AND III ASSIGNMENTS

STATION TITLE	CONDITION I Billet No.	CONDITION III Billet No.	Billet No.	Billet No.
CIC (Air)				
1. Air Controller	03001	03002	03003	03004
2. Assistant Air Controller	03002			
3. CID Net Talker	03020			
(Condition III - Plotter)		03020	03021	03022
4. CID Net Plotter	03021			
5. A/C Net Talker/Plotter	03017	03017	03018	03019
6. A/C Tote Board Keeper	03018			
7. Link 14 Readout	03014	03014	03015	03016
8. Link 14 Plotter	03015	10038	10040	10041
9. Long Range Air Plotter	03029			
(Condition III - LR/VP				
Plotter (25JS))		03029	03030	03031
10. Short Range Air Plotter	03030			
11. Radar Control Officer	03003	03005	03006	03007
12. IFF/SIF Readout	03022			
13. JA/JX Talker	04209			
(Condition III - JA/JL				
Talker)		02015	10038	10042
14. JL Phone Talker	03033			
15. Air Search Radar				
Operator (25JS)	03026			
(Condition III - SL/LR				
Tracker SPS-29				
Radar Operator)		03026	03027	03028
16. Long Range Tracker (25JS)	03027			
17. Short Range Tracker	03028			
CIC (Surface)				
18. PRITAC Recorder	03007			
19. Surface Supervisor	03004	03008	03009	03010
20. Maneuvering Board Operator	03008			
21. Surface Search				
Radar Operator	03009	03102	03103	03104
22. DRT Operator	03016	03032	03033	03034
23. Surface Status Board Keeper	03031	05028	05029	05030
24. CI Net Talker/Recorder	03019	03106	03107	03108
25. Tactical Signal				
Coder/Recorder	03010			
26. JA Phone Talker	03034			
(Condition III - JA/JL				
Phone Talker)		05031	05032	05051
27. JL Phone Talker	03036			
28. Surface Summary Plotter	03024			
CIC (EW)				
29. EW Supervisor	03011			
(Condition III - Status				
Board/(81JS) Talker)		03011	03012	03013
30. ESM Operator	03023	03023	03024	03023
31. ESM Talker/Plotter	03025			
32. ESM Status Board				
Keeper (81JS)	03035	03035	03036	03037

36.141

Figure 9-1.—Typical conventional CG manning requirements.

figure 9-1. Watch station requirements for Condition I often exceed the Operations Specialist (OS) allowance. Personnel from other divisions, therefore, augment OS personnel to fully man CIC during general quarters (providing, of course, that the ship is manned at its authorized personnel strength). If CIC is undermanned, then adjustments must be made by combining some stations, such as billets 15, 16, and 17 (fig. 9-1). Primary stations must be manned to the

CONDITION I AND III ASSIGNMENTS

STATION TITLE	Condition I	Condition III		
	Billet No.	Billet No.	Billet No.	Billet No.
CIC				
1. Supervisor	03001			
2. Air Intercept Controller #1	03002	03001	03002	03003
3. Air Intercept Controller #2	03003			
4. Track Supervisor	03004	03004	03008	03012
5. Radar Set Controller	04218	04219	04220	04221
6. Air Tracker (Cond. III -	03006			
Detector Tracker)		03019	03020	03021
7. Special Tracker #1	03007	03022	03023	03024
8. Special Tracker #2	03008			
9. CID Plotter/Talker	03019	03025	03026	03027
10. CID Recorder (Cond. III -	03020			
CID Recorder/				
PRITAC Operator)		03028	03029	03030
11. NTDS Surface Console				
Operator	03010	03031	03032	03033
12. Height Size Console				
Operator #1	03011			
13. Height Size Console				
Operator #2	03012			
14. Surface Supervisor	03013	03013	03017	03018
15. Surface Tracker	03021			
16. Dead Reckoning Tracer				
Operator	03022			
17. CI Net Talker	03023	03037	03038	03039
18. EW Supervisor	03005	03005	03006	03007
19. ESM Operator	03009	03009	03010	03011
20. ESM Recorder	03017			
21. ESM Key Set Operator (NTDS)	03018			
22. AC Net Plotter/Talker	03034	03034	03035	03036
23. Surface Summary Plotter	03024			
24. Airborne Early Warning				
Tracker	03025			
25. Detector Tracker	03026			
26. Anti-Submarine Air				
Controller	03014			
27. NC-2 North Plotter	03015	03014	03015	03016
28. NC-2 South Plotter	03016			
29. PRITAC Talker/Recorder	03027			
30. Screen TAC Talker/Recorder	03028			
31. Status Board Keeper	03029			
32. Status Board Keeper	03030			
33. JA Talker	03036			
34. JL Talker	03037			
35. JX Talker	03033			
36. 21JS Talker	03035			

maximum extent possible (radar operators, plotters, essential telephone talkers, and so on).

Officers assigned to CIC include a watch officer for all conditions of readiness. For Condition I, additional officers include an evaluator (or, in some ships, a tactical action officer), a communications officer, and a weapons liaison officer. Additional officers, if available, are assigned as desired.

Figure 9-3 illustrates general quarters stations for a representative CIC.

COMMAND RELATIONS

The primary task of CIC is to provide command with evaluated tactical and strategic information to enable the commanding officer to determine a course of action. Therefore, the CIC watch officer should immediately report pertinent information (the bridge should not have to make inquiries about a radar contact, for instance) and follow through with amplifying reports as the situation dictates.

Aboard a flagship, CIC comes under the operational control of the flag. In addition to carrying out its functions with regard to the commanding officer, CIC performs additional functions for the flag, such as processing combat information from all CICs in the task organization.

EQUIPMENT

A variety of both electronic and nonelectronic equipments are employed by a ship's CIC, the

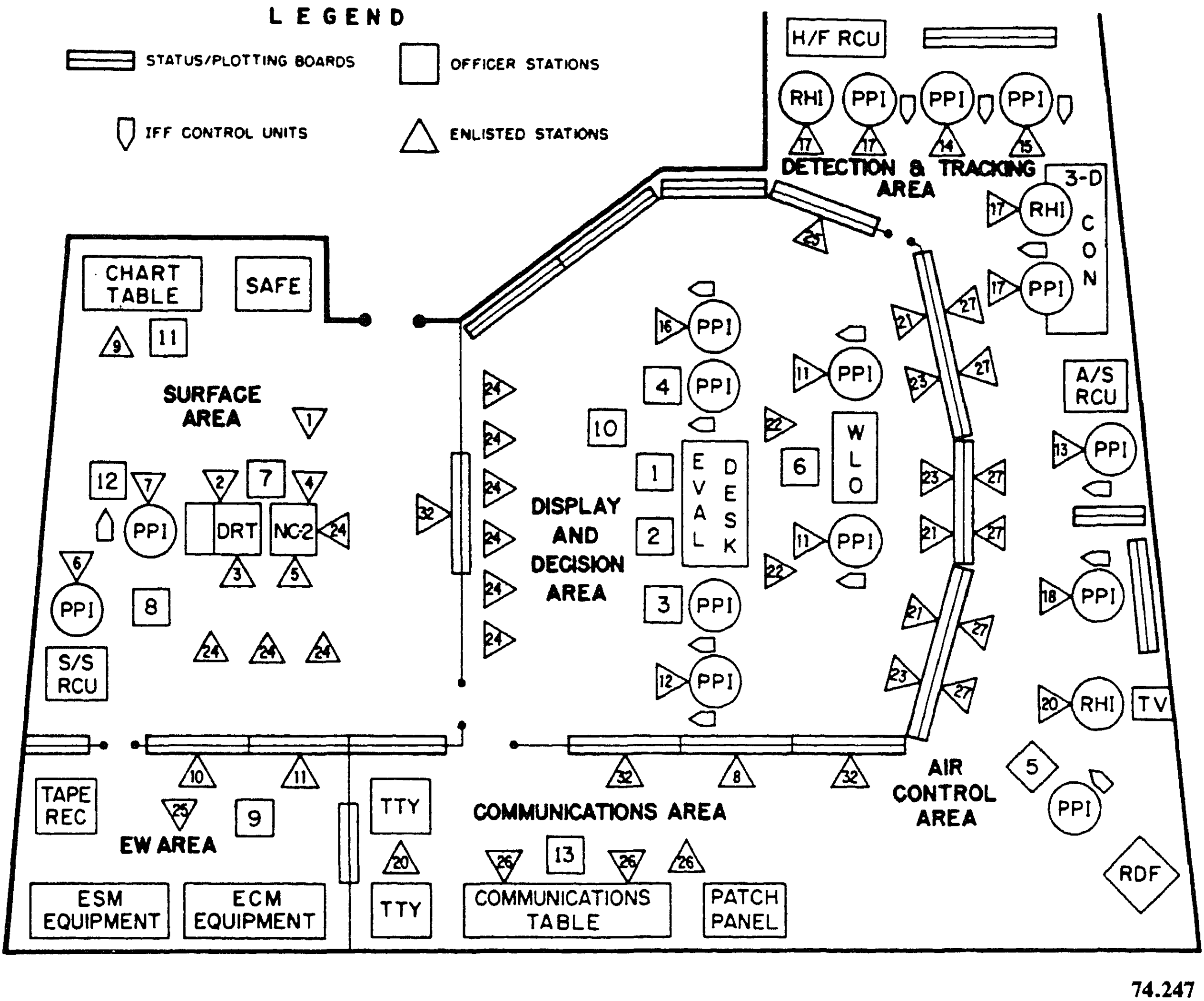


Figure 9-3.—Enlisted and officer Condition I stations in CIC.

quantity and type dependent on the type of ship and the ship's mission. They may be broadly categorized as sensors, communications, and displays.

SENSORS

Many types of sensors are used by CIC or from which CIC obtains information, but our discussion is limited to search radars and related equipment. Sonar and weapons control radars, for example, are not discussed because they are not under CIC's control.

No single radar has been developed to perform the combined functions of surface search, air search, height finding, and fire control. Power requirements, frequency, pulsewidth, beamwidth limitations, and other factors preclude such an all-purpose radar. As a result, most radars are designed for a specific purpose, although they may be capable of performing other functions to some extent. Fire control radars, for example, have a limited surface search capability; height finders may be used as secondary air search radars. Because of the many different models of each type, only general characteristics and representative systems are discussed.

Surface Search Radar

The principal function of a surface search radar is the detection and determination of bearing and range of surface targets and low-flying aircraft, while maintaining a 360° search around the ship. A surface search radar must have moderate precision in range and bearing determination and a sufficiently high resolution of close-together targets to indicate separate contacts.

Because of the short detection range requirements, the transmitter frequency is high, which permits a smaller antenna (with consequent weight and space savings) that is highly directional.

Narrow pulsewidths (PW) permit short minimum ranges, good range resolution (the ability to distinguish between two targets close together in range on the same bearing), and satisfactory range accuracy.

A high pulse repetition frequency (PRF) and a rapid antenna rotation rate provide maximum illumination of targets to compensate for the relatively low peak power transmitted during the short pulse transmission time.

Wide vertical beamwidths compensate for pitch and roll of the ship. Narrow horizontal beamwidths permit reasonably accurate bearing determination and a good bearing resolution (the ability to distinguish between two targets at the same range close together in bearing).

Under normal atmospheric conditions, the maximum detection range is about one-third greater than the optical horizon, depending on the type of target. Abnormal conditions can considerably shorten or lengthen detection ranges.

A typical surface search radar is the widely-installed AN/SPS 10 (model). It operates in the frequency range 5450 to 5825 MHz, with a peak power output of 285 kW. The PRF can be varied between 625 and 650 pulses per second (pps).

Two pulsewidths are available: 1.3 μs (microseconds) for long range search and 0.25 μs for short range requirements, such as radar navigation

The antenna rotates clockwise at 16 revolutions per minute. Radiated signals have a vertical beamwidth of 16° and a horizontal beamwidth of 1.5°. Having discussed the basic parameters of the typical surface search radar, there is one measurement on the radar that will be of use to every OOD and CICWO. This measurement is called ring time.

Ring time provides a relative indication of a radar receiver's efficiency. A portion of the transmitter's output is coupled into an echo box and the box tuned until it is in resonance (ringing) with the transmitter frequency, as determined by an output meter on the box. The echo box output is fed through the receiver to indicators.

On a PPI, an echo resembling sea return extends outward several thousand yards from the scope's center. (On some equipment, the echo will appear as spokes, caused by automatic tuning of the echo box back and forth across the frequency of the transmitter). The receiver is tuned for maximum extension of the echo, then the distance is measured. This measurement is the radar's ring time. A watch-to-watch log should be kept of ring time measurements; any marked decrease in values indicates a deterioration in the receiver's performance.

The following are some applications of surface search radars.

1. To indicate the presence of surface craft and facilitate determination of their course and speed
2. To coach fire control radar onto a target
3. To provide security against attack at night, during conditions of poor visibility, or from behind a smokescreen

4. To aid in scouting
5. To obtain ranges and bearings on prominent landmarks and buoys as an aid to piloting, especially at night and in conditions of poor visibility
6. To facilitate station keeping
7. To detect low-flying aircraft
8. To detect certain weather phenomena
9. To detect submarine periscopes
10. To control small craft

Air Search Radar

An air search radar's primary requisite is the ability to detect aircraft and missiles at long ranges. Enemy aircraft must be detected far from the force for ships to have sufficient time to be ready to repel an attack, and to enable the combat air patrol (CAP) or missiles to intercept a raid before it can hit the force. However, in air search radar, some sacrifice in the degree of resolution between targets is made to accomplish this main task of long-range detection.

Requirements and characteristics of air search radars are as follows:

1. Requirements:

   a. Maximum detection range
   b. High average power

2. Characteristics:

   a. Wide PW
   b. Low frequency
   c. Low PRF
   d. Slow antenna rotation rate
   e. Wide beamwidth in vertical plane
   f. Medium beamwidth in horizontal plane

Applications of air search radars include the following:

1. Warning of approaching aircraft and missiles before they can be sighted visually, so that

a. the direction from which an attack may develop may be indicated.

b. fighters may be launched in time if an air attack is imminent.

c. antiaircraft defenses may be brought to the proper degree of readiness in sufficient time.

2. Allowing constant observation of movements of enemy aircraft, once detected, and controlling CAP to a position suitable for interception.

3. Providing security against night attack and attacks during conditions of poor visibility.

4. Providing means of aircraft control, when it is necessary for them to be on a specific geographic track such as an antisubmarine barrier or search and rescue pattern.

Height-Finding Radar

Height-finding radars are used to determine target altitude by placing a narrow vertical beam on the target and computing its height from it position angle and slant range. The computing circuits are critical, requiring frequent calibration. Altitude measurement of targets at low heights is unreliable because some energy from the beam is reflected from the surface of the water, introducing measurement errors.

Typical requirements and characteristics of height finders are as follows:

1. Requirements:

   a. High peak power
   b. Very narrow vertical beam
   c. Stabilized antenna

2. Characteristics:

   a. Medium to high pulsewidth
   b. Low to medium frequency
   c. Medium to high PRF

Some applications of height-finding radar are as follows:

1. Obtain range, bearing, and altitude data on enemy aircraft and missiles to assist in control of CAP to a suitable intercept position
2. Detect low-flying aircraft
3. Range on distant land
4. Track aircraft over land
5. Detect certain weather phenomena
6. Track weather balloons

Remote Indicators

In the early days of radar, the display of information was confined to a single unit called the radar console. It soon became apparent, however, that full benefit could not be taken of

the radar since only the radar operator could see the indicator. Other physically separated stations also required a visual indication of both air and surface search radar information. Thus, remote indicators (repeaters) capable of accepting inputs from more than one type of radar were developed. By having several repeaters, flexibility was achieved. The range scale on a repeater, for example, can be selected independently from the scale used at the console. The accuracy of a repeater, however, cannot exceed that of the radar itself.

There are several types of repeaters, but the type most used is the plan position indicator (PPI), which provides a polar coordinate picture of the area surrounding the ship.

Each time the radar transmits, a synchronizing pulse is simultaneously sent to the repeater to trigger the sweep, which then moves across the face of the scope in synchronization with the transmitted radar pulse. The length of the sweep is equal in time to the pulse repetition time of the radar. A radar having a PRF of 625 pps, for example, has a pulse repetition time (time between pulses) of 1600 μs, which provides a maximum theoretical range of 131 miles, based on 12.2 μs per radar mile. Thus, a repeater may be set on a 200-mile range scale, but only 131 miles of sweep are usable.

The sweep is also synchronized with the radar antenna. As the antenna rotates, so does the sweep, producing the polar coordinate picture.

Bearing and range resolution of a repeater are relatively poor, being governed by the radar's characteristics and those of the repeater itself. Bearing resolution is poor because of sweep width. Range resolution depends on the pulsewidth of the radar and the range scale in use—the longer the range scale, the poorer the resolution and accuracy. However, these limitations can be overcome if the repeater has an off-center or delayed sweep capability.

Typical of the PPI repeaters is the AN/SPA-8A shown in figure 9-4. Other models are nearly identical, differing mainly in some of their operating controls.

Electronic Warfare

Electronic warfare (EW) is the use of electromagnetic energy to determine, exploit, reduce, or prevent hostile use of the electromagnetic spectrum and actions taken to ensure our own use of the spectrum. There are three divisions within electronic warfare: electronic warfare support measures (ESM), electronic countermeasures (ECM), and electronic counter-countermeasures (ECCM). We are concerned primarily with ESM since sensors fall within this division. Specific equipment and techniques cannot be discussed, however, because of their classification.

The primary role of ESM is to detect, locate, identify, and evaluate electromagnetic transmissions for the purpose of immediate threat recognition. Detection is accomplished by a variety of electronic intercept receivers that among them cover the entire electromagnetic spectrum.

Detected signals are analyzed for their transmission characteristics and evaluated for identity, purpose, and possible threat. A radar signal, for example, is analyzed for its frequency, pulsewidth, pulse repetition frequency, beamwidth, type of scan, antenna rotation rate, and so on. The characteristics are then compared to known signals and identified if possible. If evaluated as hostile, a decision is then made as to what, if any, ECM actions are desirable. ECM options include electronic jamming and deception.

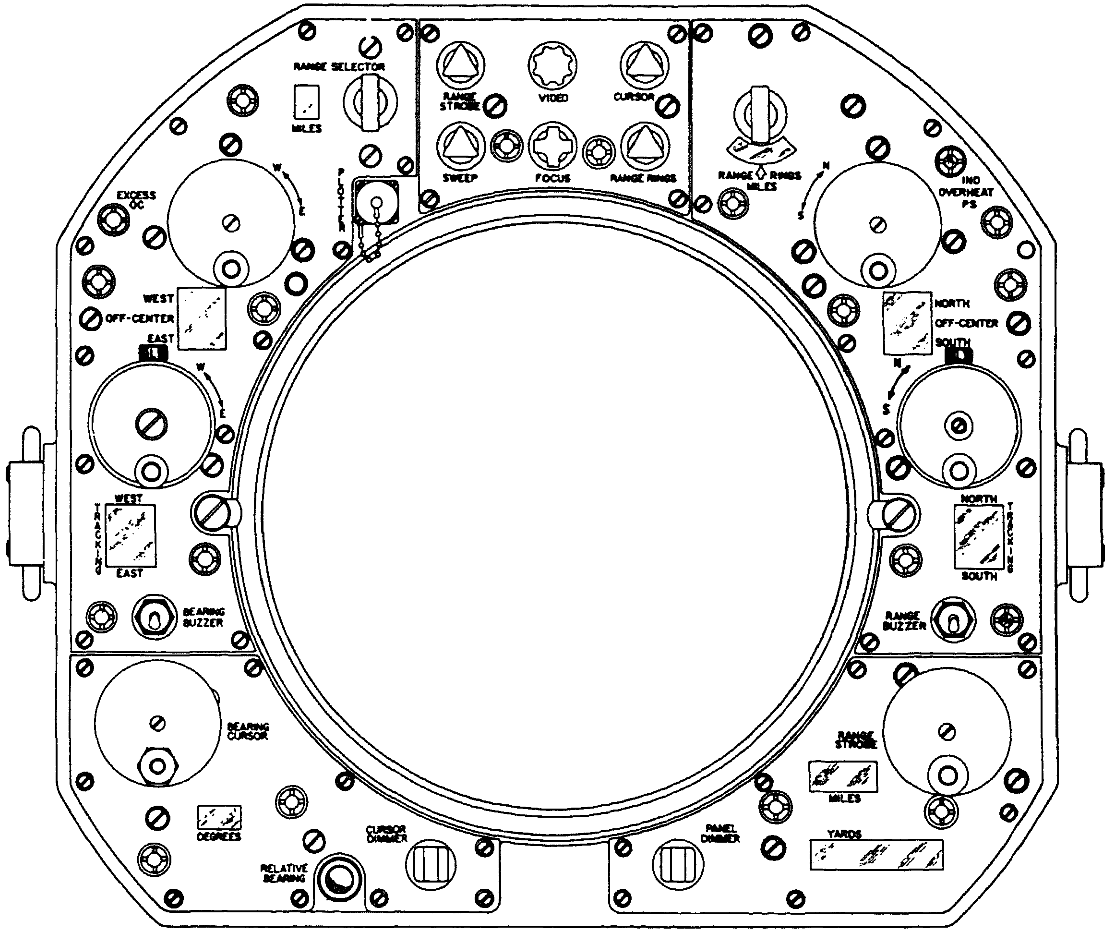
Electronic jamming is an attempt to overpower the enemy's receiver so that no useful information can be gained from the equipment. Electronic deception is an attempt to mislead an enemy in the interpretation of information received through electronic systems.

In many tactical situations, a force's only means of detecting, identifying, and tracking enemy units may be to intercept search receivers. Situations that demand radar silence also demand optimum use of intercept equipment.

RECOGNITION

With the high speeds of modern aircraft, identification of contacts in the least possible time is of utmost importance. This requirement is met with identification friend or foe (IFF) equipment. (Surface units also may be identified.) Additionally, the IFF system serves other functions, such as identifying aircraft side numbers and missions.

The basic steps of target identification are (1) challenge, (2) reply, and (3) recognition. To perform the identification process, the IFF system uses three major components: an interrogator, a transponder, and a responder. The interrogator and responder (I-R) are contained in the same unit.



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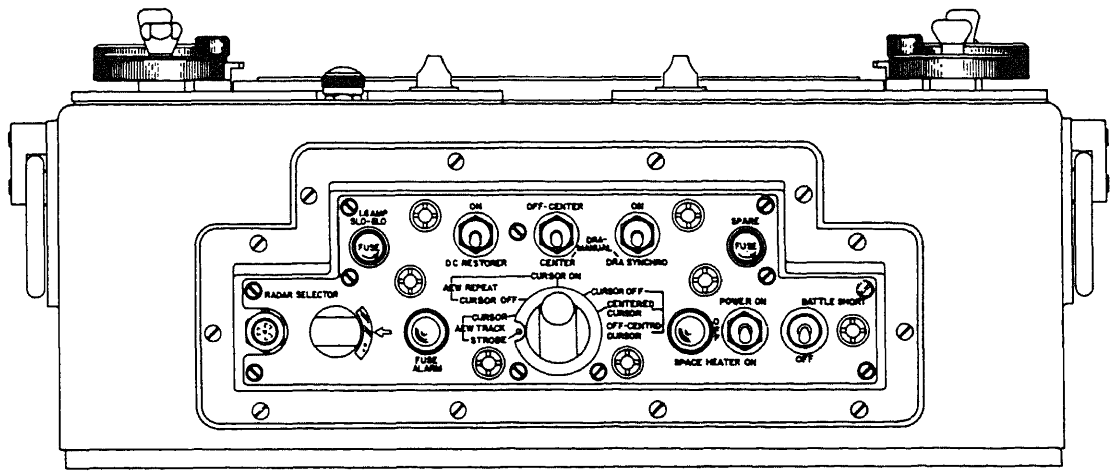

B.

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Figure 9-4.—AN/SPA-8A repeater.

The I-R unit transmits challenges and receives and decodes replies. The transponder, which is a combination receiver/transmitter operating on two different frequencies, transmits coded replies when activated by challenges from the interrogator (fig. 9-5).

Three modes of operation are available. Challenges in each mode consist of a pair of one-microsecond pulses. In mode 1, challenge pulses are 3 microseconds apart; in mode 2 they are 5 microseconds apart, and in mode 3 their spacing is 8 microseconds. Replies are displayed in the form of dashed arcs directly behind the radar contact. Operation of the system is synchronized with radar transmissions by the radar modulator.

DISPLAYS

One of the most important functions of CIC is display of information. Without a timely display of tactical and strategic data, the evaluator cannot make worthwhile recommendations to command or keep control stations informed of the current situation.

Principal CIC displays are plots and status boards. (Logs can be considered a form of display, but their primary purpose is to provide a permanent record of events, equipment conditions, messages, and so on.) Plots provide a

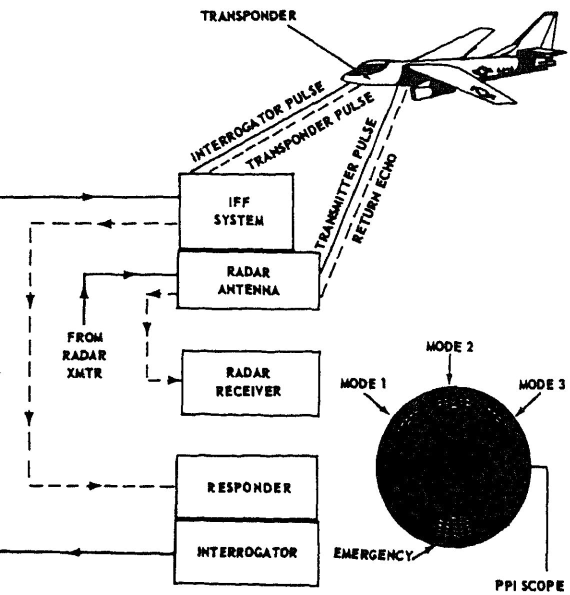

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Figure 9-5.—Cycle of IFF challenge, reply and recognition.

visual reference to the positions of friendly and enemy units and forces. Some plots are static in nature, others show movement. Some plots cover large areas and show both friendly and enemy forces; others depict only own units within a small area.

Status boards list current tactical information, which is not associated with a particular plot or, because of space limitations, cannot be presented on the plots. The type and format of plots and status boards and the information presented as described in this section are not necessarily standard, although many ships use the same or similar displays. The ship's mission, available space, and the configuration of CIC influence the types and number used.

Geographic Plot

A geographic plot shows true movement of surface, subsurface, and certain air contacts. The plot is maintained on a dead reckoning tracer (DRT) or the newer plotting system Mk NC2.

The DRT is divided into two sections—a plotting surface and a compartment containing various drive mechanisms and dial indicators (fig. 9-6). Ship's course and speed inputs from the dead reckoning analyzer drive a range/bearing projector, called the "bug." A sheet of tracing paper is secured to the glass plotting surface, through which a spot of light is projected from the bug that indicates own ship's dead reckoning position. "Marking the bug" provides a permanent record of the ship's track. A parallel motion protractor (PMP) is used to plot bearings and ranges to contacts from own ship's position (fig. 9-7). For radar navigation a chart is placed on the DRT and the PMP is used to plot bearings and ranges to landmarks to determine the ship's true position.

The DRT may be set to any range scale between one-quarter mile and 16 miles per inch. A special setting of 200 yards per inch is available for man overboard situations.

In addition to plotting contacts, uses of the DRT include station keeping, search and rescue operations, radar piloting, shore bombardment, and antisubmarine operations.

Surface Summary Plot

A surface summary plot is a comprehensive relative picture of the positions and tracks of surface units, relevant geographic points, and any other data required to understand the complete

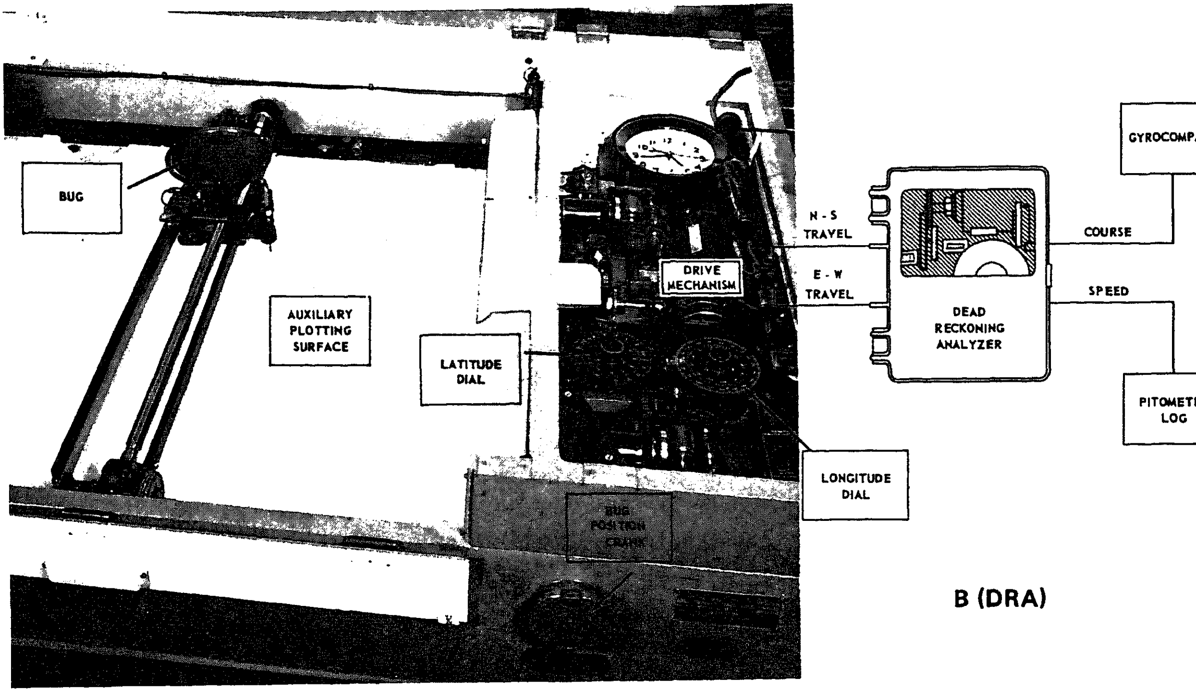

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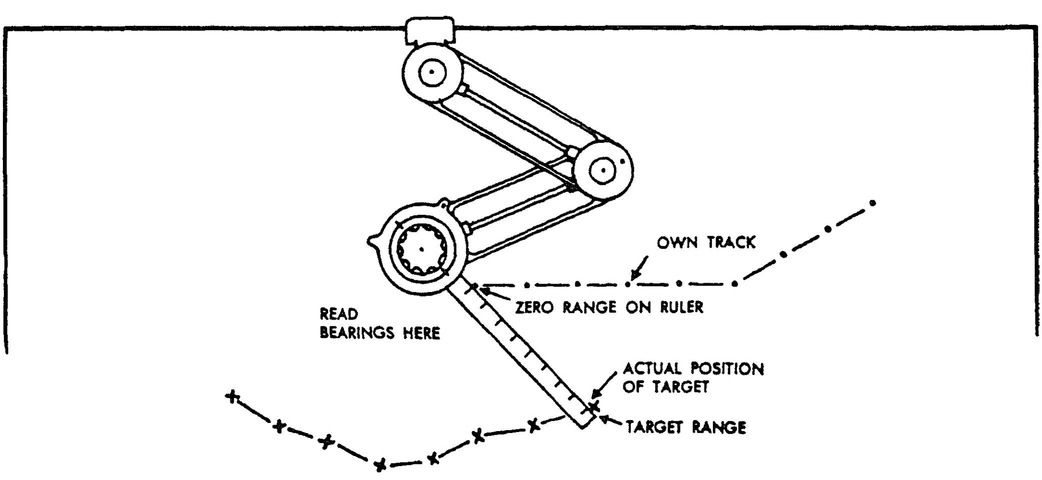
Figure 9-6.—Dead reckoning tracer system.



surface picture. It is kept in terms of polar coordinates on a maneuvering board or, preferably, on a vertical edge-lighted plotting board.

Wind conditions, AAW sectors, force center, own formation, and contact tracks are some of the data displayed on the plot (fig. 9-8). Formation plotting symbols are shown in figure 9-9.

Air Summary Plot

The air summary plot is one of the main displays in CIC. It presents a relative display of the air picture within an area of at least 200 miles radius from own ship. Surface forces of significance, dangers to air navigation, position of the sun, land, and enemy military areas are

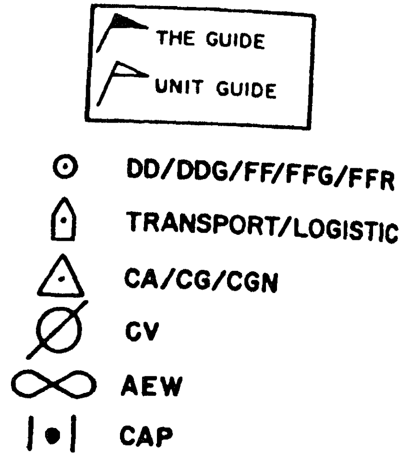


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Figure 9-9.—Formation symbols.

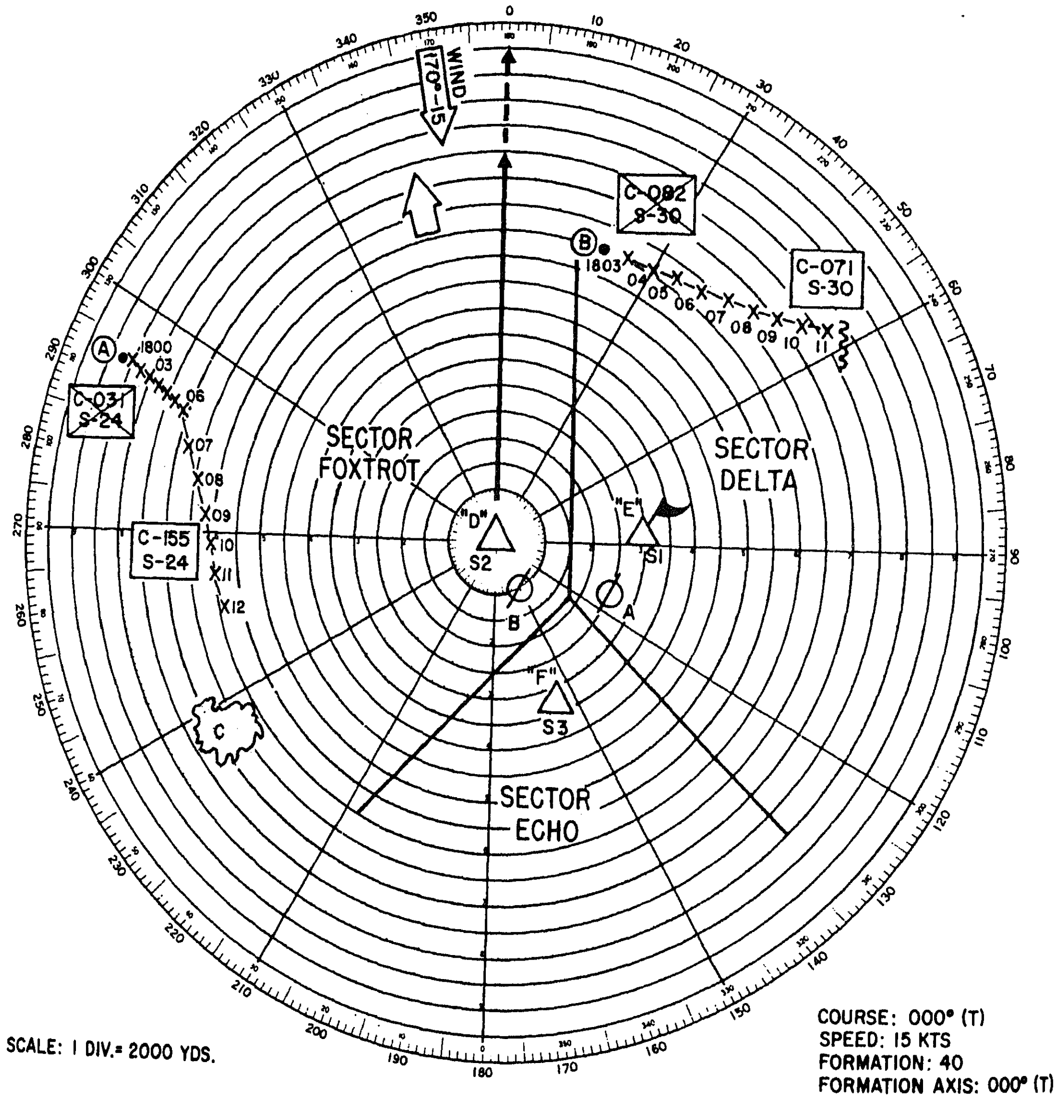

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Figure 9-8.—The surfa

Table 9-1.—NTDS Symbology for Use for Non-NTDS Ships

Basic Symbols

	Friendly	Unknown	Hostile
Air	⌒	⊓	∧
Surface	○	▭	◊
Subsurface	∪	⊔	∨

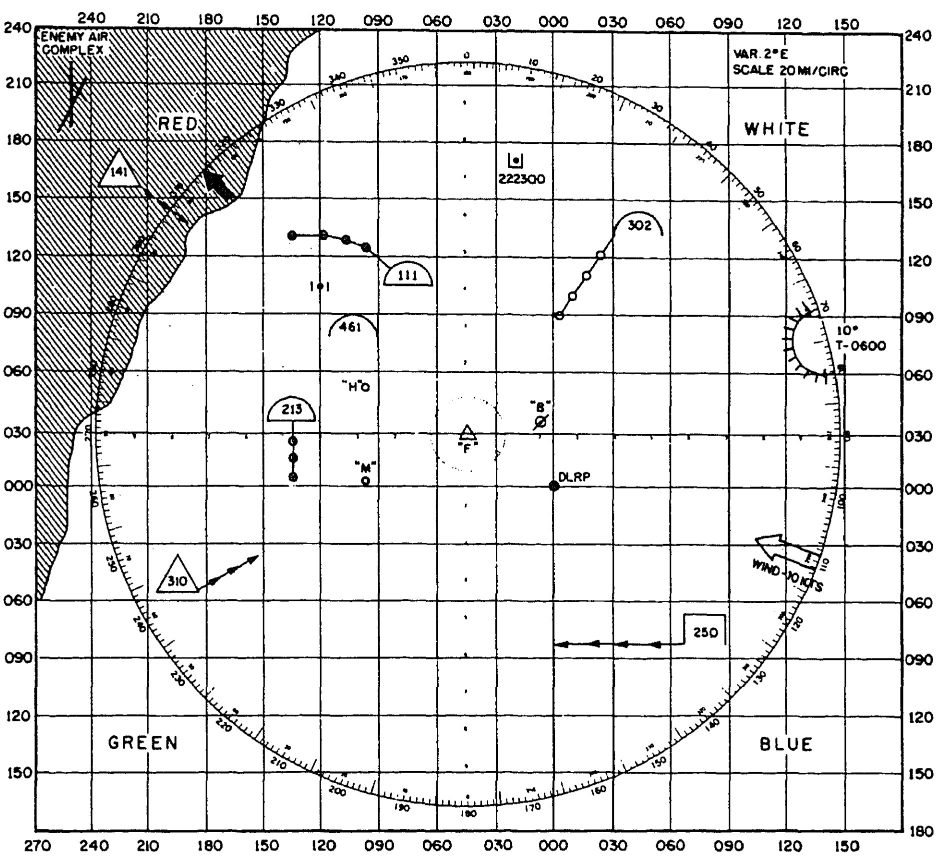
Amplifying Data

Interceptor assigned a bogey
Interceptor engaged with bogey
This bogey designated for intercept
Bogey engaged by CAP
Engaged hostile surface contact
Engaged hostile subsurface contact
Bogey designated a missile target
Missile directors locked on bogey
Single
Few (2–4)
Many (5 or more)
Downed friendly
Steered CAP station 5

some of the information displayed (fig. 9-10). The air summary plot is of prime importance to the evaluator, weapons liaison officer, and other stations in CIC concerned with the air picture. The symbols shown in table 9-1 have been adapted from NTDS symbology for use by non-NTDS ships.

Polar coordinates are used for plotting own radar contacts. For plotting contacts reported by other ships (particularly NTDS Link 14 reports) and for reporting own contacts to other units, a Cartesian grid is superimposed on the plot. The grid is divided into four quadrants, each designated by a color. Red indicates the northwest quadrant, white the northeast, blue the southeast, and green the southwest quadrant. Grid center, called data link reference point (DLRP) for NTDS purposes, is established by the OTC.

Grid positions are given as a color followed by six digits. The first three digits indicate the number of miles east or west from DLRP, and the last three digits indicate the number of



36.65A

Figure 9-10.—Air summary plot.

miles north or south. Own ship's position (station F) in figure 9-10, for example, is RED 045 030.

Tote Board

If all the information concerning air contacts (course, speed, altitude, and so on) were placed on the air summary plot alongside each track, the plot would soon become hopelessly cluttered and lose its value. Most air contact information, therefore, is placed on a status board, called the tote board, adjacent to the air plot.

The information displayed on the tote board (fig. 9-11) concerns bogeys (enemy or unknown contacts), CAP (combat air patrol), and other friendly aircraft as required. The bogey section provides the designation (alphanumeric and/or NTDS track number), course, speed, altitude, composition, time of the information, and the weapon assigned for engagement.

Friendly information includes CAP call signs, stations, angels (altitude), and state (amount of fuel and the type and number of weapons remaining).

Surface Status Board

The surface status board supplements the surface summary plot. Designs vary, of course, from ship to ship, but all have spaces for essential data concerning the formation. On the board shown in figure 9-12, the top section is devoted to essential formation data plus wind and sea conditions. Other information that is shown on some boards includes times of sunrise, sunset, moonrise, and moonset; set and drift; and direction and distance to nearest land.

The remaining space is devoted to contact information, designation, bearing, range, course, speed, closest point of approach, and time of the information.

Only those plots and status boards maintained by most ships have been discussed. There are many others in use, the type depending on the individual ship's requirements. Some of the other types are given in the following:

1. Air event board. Lists all aircraft and their calls, mission, time of launch/recovery, and so on, for each launch from a carrier.

2. ASW status board and plot. These are discussed in the next chapter.

3. Electronic warfare. Lists emission control conditions, radar guards, anticipated and actual ESM intercepts, and identifications made.

4. Communication/equipment status board. Lists communication equipment in use; circuit designation, frequency, and purpose; equipment status (up, down, standby).

5. Voice call sign board.

6. Gunfire support board. Contains details of a fire mission: type of target; coordinates; type of fire, ammunition, and control; spots; and so on.

7. Strategic plot. A large area true display on which is plotted information concerning the position, movement, strength, and other data of own and enemy sea, land, and air forces. This display is usually maintained on a nautical chart of suitable scale, but it may be shown on a vertical plot.

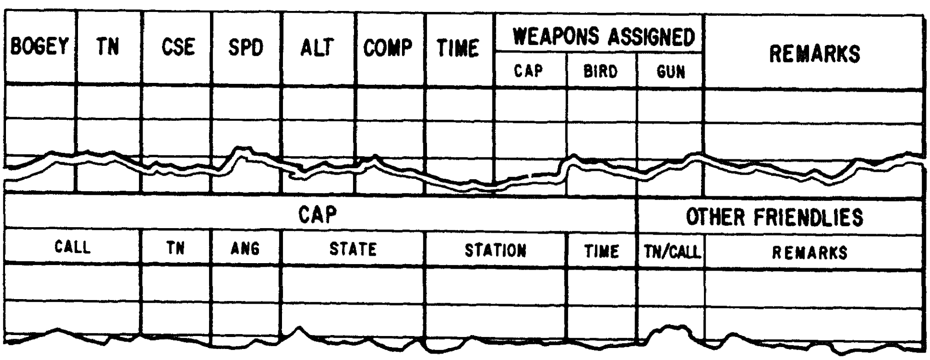


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Figure 9-11.—Tote board.

INTERNAL COMMUNICATIONS

Ten types of shipboard internal communications are used in CIC. They are (1) voice tubes, (2) ship's service telephones, (3) messengers, (4) teletypewriter, (5) television, (6) pneumatic tubes, (7) target designation equipment, (8) multichannel (MC) systems, (9) sound-powered telephone systems, and (10) the integrated voice communications system (IVCS). Not every ship's CIC has all of these means of communication. The larger ships do, but the smaller types may have only a few of them.

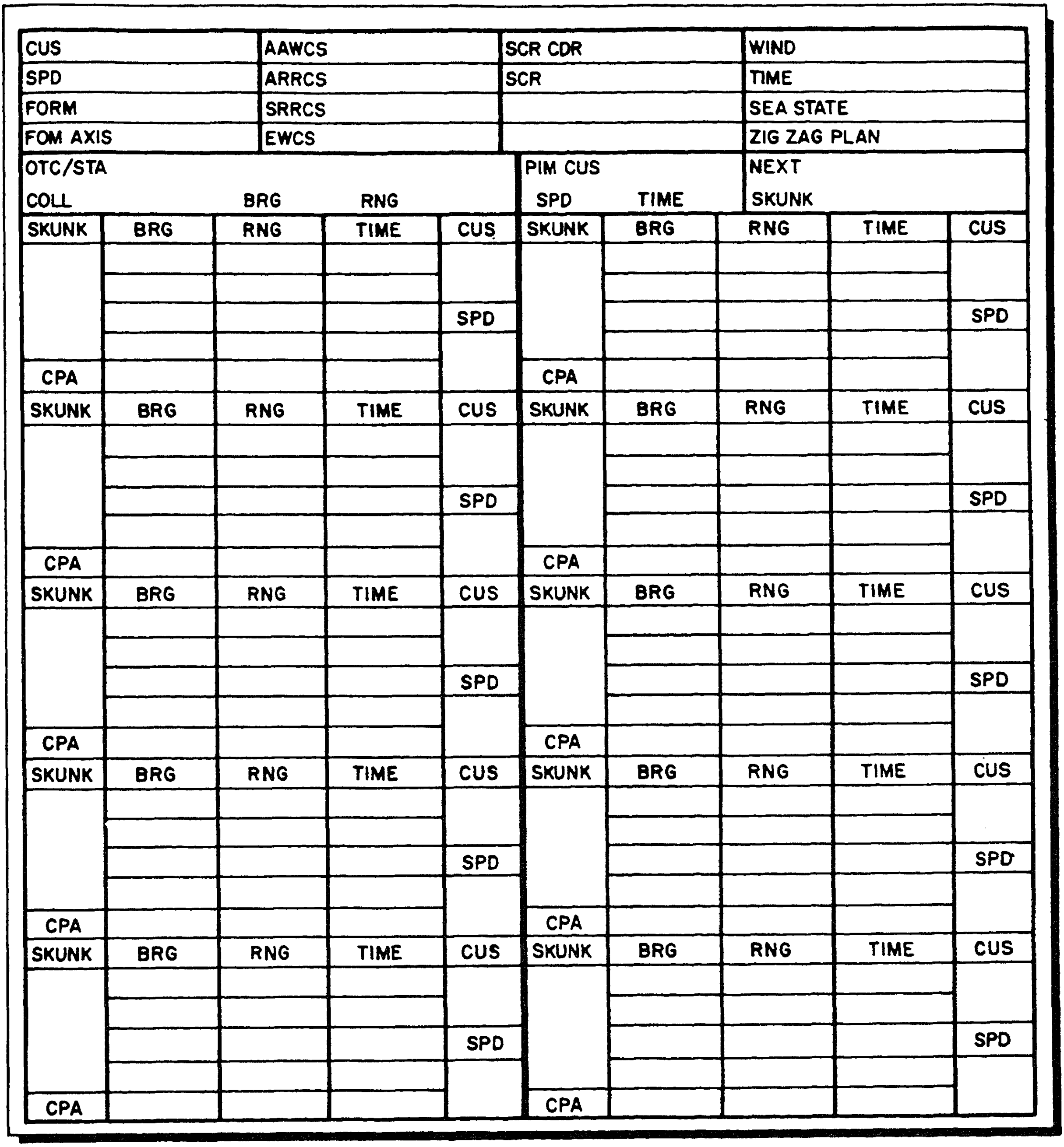

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Figure 9-12.—Sample surface status board.

Multichannel Systems

Two general types of multichannel (MC) systems are the central amplifier and intercommunication. The central amplifier system is a one-way system that serves as the ship's public address circuit for broadcasting information throughout the ship or to selected sections of the ship. Topside speakers, for example, can be cut out of the circuit, as can those in officers' country, when routine word is passed.

Intercommunication systems provide two-way communications between stations. Each intercom unit (fig. 9-13) has its own amplifier and reproducer, the latter serving as both a microphone and a loudspeaker.

Sound-Powered Telephones

Sound-powered (S/P) telephones are instruments in which power is derived solely from the talker's voice. Because no external source of power is required, S/P telephones are a dependable means of internal communications. They are simply constructed and easily maintained. In case of a casualty to a component either earpiece may also be used as a transmitter, and the mouthpiece may be used as a receiver.

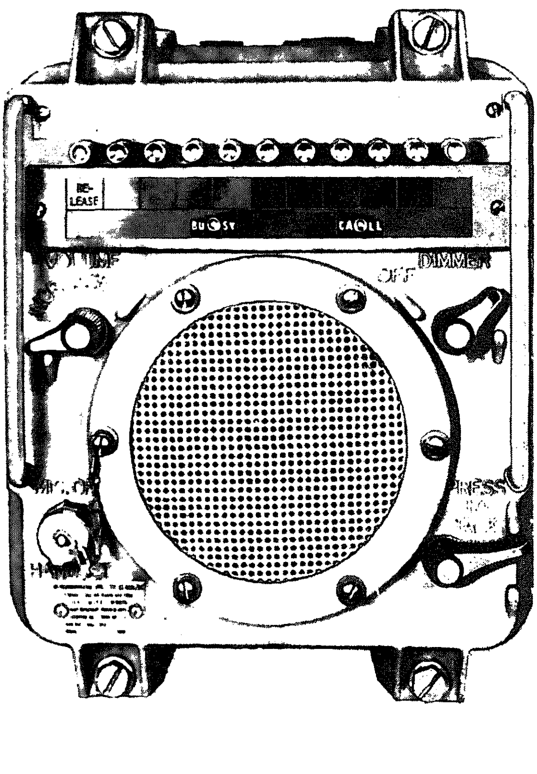

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Figure 9-13.—Typical MC unit.

A combatant unit has many S/P telephone circuits, each assigned a specific purpose. Circuits are grouped in three general systems: primary, auxiliary, and supplementary. The primary system includes circuits required to maneuver the ship and to control weapons, engineering, surveillance, and damage control functions.

Circuits in the auxiliary system duplicate many of those in the primary system, but they are physically separated from them to minimize loss of communications in the event of battle damage.

The supplementary system consists of several short, direct circuits, such as from the bridge to the wardroom, or the radar antenna platform to an electronic casualty repair station. Most, but not all, of these circuits contain a buzzer system to alert the station being called.

Table 9-2 lists the primary sound-powered telephone circuits for the Spruance (DD 963) class destroyer. Most, but not all, of these circuits are available in CIC.

NAVAL TACTICAL DATA SYSTEM

By the end of World War II, commanders already were aware that CIC had nearly reached the saturation point of its data-handling capability. The advent of supersonic aircraft and missiles, together with other technological advances, further emphasized the inadequacy of conventional plotting and communication methods. After several years of study and development, the first naval tactical data system (NTDS) became operational in the early 1960s.

The NTDS is essentially a computerized, digital, information processing system that provides a real-time display of the tactical situation on which commanders can base tactical decisions. This improved capability is reflected in the following advantages over a conventional combat information handling system:

1. Rapid processing of air, surface, and subsurface surveillance data collected by the sensors of TDS-equipped units
2. Real-time automatic exchange of air, surface, and subsurface track information by digital data link
3. Close or advisory control of friendly air, surface, and subsurface forces

Circuit	Designator
Captain's Battle	JA
Weapons Control	JC
Helicopter Control	1JG
Helo and Miscellaneous Fuel	4JG1
Lookout	JL
Dual Purpose Batt Control Fwd	2JP1
Dual Purpose Batt Control Aft	2JP2
Light Machine Gun Control	5JP
ASW Weapon Control	8JP
Plotters Transfer	JS
CIC Information	1JS
NTDS Coordination	2JS
Surface Search Radar	21JS
Long Range Air Search Radar	22JS
Sonar Information	61JS
ECM Info/Plotters	81JS
TGT Designation Cont No. 1	JT1
TGT Designation Cont No. 2	JT2
Maneuvering and Docking	1JV
Engineer's (Engines)	2JV
Engineer's (Fuel and Stab)	4JV
Engineer's (Electrical)	5JV
Ship Control Bearing	JW
Radio and Signals	JX
Damage and Stability Control	2JZ
Forward Repair	4JZ
After Repair	5JZ
Engineer's (Repair)	7JZ

4. Continuous tactical data teletype reports to non-TDS units afloat and ashore through standard one-way teletype circuits

5. Real-time command and control facilities for embarked commanders

6. Real-time exchange of information by digital data link among naval, joint, and Allied units

The NTDS does have limitations. Although it greatly enhances the ability to process, disseminate, and use tactical information, it does not directly increase the ability of individual units to acquire this information. It also does not determine the accuracy of data inputs and subsequent outputs. Interactions between tactical data systems necessitate strict compliance with standardized operating procedures throughout the force because errors in procedure or judgment are automatically broadcast to all units and can TDS units are operating simultaneously, close force level supervision of TDS operations is required.

Instantaneous exchange of tactical data between computers of force NTDS units is possible when proper communication links are activated. Major fleet units currently configured with the NTDS include aircraft carriers and cruisers. DD 963 (Spruance) class destroyers are also equipped with NTDS, which is oriented primarily toward the conduct of antisubmarine warfare. Other fleet units have tactical data systems that are similar to and completely or partially compatible with the NTDS. These units include Marine Corps units, AEW aircraft, P-3C and S-3A aircraft, amphibious command ships, guided missile destroyers, and amphibious assault ships. Some NATO navies have developed or are developing tactical data systems that are compatible with those of the United States.

COMMUNICATION LINKS

There are three separate NTDS communication links: 4A, 11, and 14.

Link 4A is used to communicate between NTDS ships and aircraft appropriately equipped. Guidance instructions to interceptors and other aircraft are transmitted automatically on this data link.

Link 11 connects all NTDS surface units of a force. Four basic types of information are transmitted via this link:

1. Track status reports. Information includes track identification, course, speed, height, size, position, and so on.
2. Weapons status and orders.
3. EW (electronic warfare) reports.
4. Control messages that regulate the operation of the data link network.

Data exchange between all computers is automatic and continuous. One ship is designated as the controlling unit (assign track numbers, receive and relay reports from non-NTDS units, and so on).

Link 14 is used for communications from NTDS ships to non-NTDS ships via radioteletype (TTY). Aboard the non-NTDS ship, a talker at the TTY relays pertinent information to various plotters and status board keepers.

SYSTEM COMPONENTS

The NTDS, as well as associated tactical data system, consists of three basic components: the equipment (hardware), the personnel (supervisors, operators, and maintenance), and the computer programs (software). These elements are integrated and organized to support flag and commanding officers in discharging their decision-making responsibilities. A representative system is shown in figure 9-14.

PROGRAMS

A computer program (software) is a compliance of orders and instructions, usually placed on magnetic tape, and loaded into the computer when the system is set up for operation. These orders and instructions tell the computer how to perform certain actions, process incoming data, and respond to operator actions.

Each NTDS computer program is tailored to the equipment and mission of the ship where it is to be used. To facilitate this tailoring process, all shipboard computer programs are written in functional parts called program modules, each of which performs a precisely defined portion of the overall program's task. Each module is designed to allow it to communicate with any other module in a program without regard for the internal workings of the other module. This communication may consist of data to be transferred or of instructions to perform specific program operations.

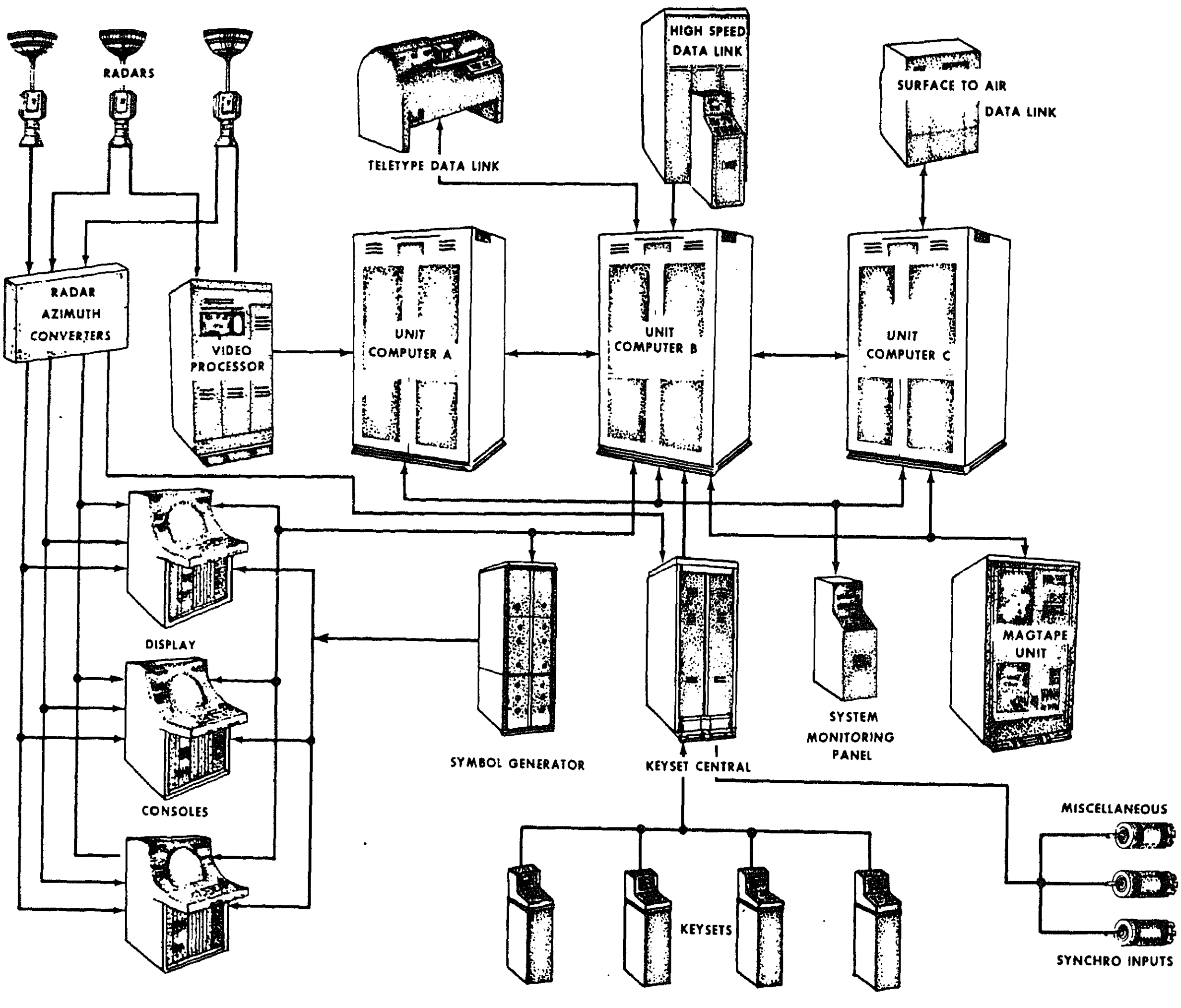

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Figure 9-14.—Naval tactical data system diagram.

MODES OF OPERATION

While NTDS relieves operating personnel of many of the duties associated with conventional CICs, such as manual plotting and computing (course, speed, and so on), it does not replace them. Thus, the number of personnel required to man an NTDS CIC closely parallels the number of personnel required to man a conventional CIC. CIC NTDS personnel are required to man data display consoles to manually input data into the computer, such as radar and IFF information, and to perform functions based on processed computer output data, such as weapons assignment and air intercept control.

Each data display console is designed to supply a specific type of data to the computer, based on certain hardwired and software configurations. Consoles may be hardwired as either input or user types. Software requirements further divide input and output functions into modes of operation. The actions which may be performed by an operator, at either an input or output console, are determined by the position of the mode selector switch on that console.

Data input operators have the responsibility of detecting, identifying, and tracking all air, surface, and subsurface targets within the ship's surveillance area.

In the user modes, operators of data display consoles use data entered by input console operators and data generated by the computer program. User modes of operation involve two basic processes: surface maneuvering and combat direction. Basically, user modes perform the decision-making functions of NTDS.

RELATED TACTICAL DATA SYSTEMS

As previously mentioned, there are several tactical data systems used by the Navy, some of which use the same hardware. These systems have configurations similar to the NTDS. The major difference between them is in the software design, since each system was established with the primary mission of a particular unit in mind.

For instance, NTDS, the first system used by the Navy, was designed to assist combatant units in rapidly tracking, engaging, and destroying all threats to a task force, while simultaneously conducting strike operations in an objective area. Other systems, briefly explained in subsequent paragraphs, perform other functions although they all are compatible with NTDS on Link 11. They can exchange track information and weapons orders information.

AIRBORNE TACTICAL DATA SYSTEM

The airborne tactical data system (ATDS) is normally operated as an extension of the shipborne NTDS and/or land based MACCS. It is installed on the E-2B/C Hawkeye aircraft.

The ATDS equipment, which is much more compact than NTDS equipment, performs numerous detection and computation functions either automatically or semiautomatically.

AMPHIBIOUS FLAGSHIP DATA SYSTEM

The amphibious flagship data system (AFDS) is installed on amphibious command ship (LCCs) to permit an amphibious commander to control an amphibious objective area. The system was designed to provide a real-time, tactical command post and communication center for both the amphibious task force commander and the landing force commander.

The primary functions of the AFDS include force air warfare coordination, air management, surface operations, and display. Air management functions are broken down into air control, intercept control, objective area flight coordination, and airborne weapons support.

INTEGRATED TACTICAL AMPHIBIOUS WARFARE DATA SYSTEM

The integrated tactical amphibious warfare data system (ITAWDS) is a computer based processing system designed for and installed on an amphibious assault ship (LHA). It is designed to allow the operation of normal TDS functions, amphibious warfare functions, and other shipboard functions (supply and accounting, 3-M Systems, and so on) on a time-sharing basis within a single computer.

ADVANCED AVIONICS ANTISUBMARINE WARFARE SYSTEM

The advanced avionics antisubmarine warfare system is an airborne antisubmarine system installed in P-3C and S-3A aircraft. It is designed to detect, classify, track, and destroy submarines. This system employs modern digital data processing techniques in the manner of NTDS, which receives diverse inputs, then organizes, stores, times, sequences, and makes required decisions

CHAPTER 10

ANTIAIR WARFARE

Antiair warfare (AAW) is defined as that action required to destroy or to reduce to an acceptable level the enemy air and missile threat. It includes such measures as offensive strikes against enemy air bases and missile sites. AAW also includes defensive operations, such as the use of interceptors, surface-to-air missiles, AA guns, electronic countermeasures, cover, concealment, dispersion, deception (including electronic), and mobility.

Successful conduct of AAW involves coordination of detection equipment, weapons systems, and communications. Successful conduct also depends on the tactics employed, the disposition of the force, the operating efficiency of equipment, and the capability of personnel.

As radar is the primary method of detecting and guiding weapons to incoming air targets, an introduction to the principles of radar is provided before the broader topic of AAW is discussed.

RADAR

Radar is a major source of information to the modern day sailor. Developed during World War II radar (an acronym for *ra*dio *d*etection *a*nd *r*anging), is a method, using radio waves, to detect and track objects over large distances and in any weather.

OPERATION

If you shout at a cliff, you will hear an echo after a period of time. The farther from the cliff the longer the time period. What happens is that part of the sound waves transmitted by you are reflected from the cliff back to you. The time lag is proportional to your distance from the cliff (sound travels at approximately 1,100 feet per second). Similarly radio waves will be reflected and an echo may be received by an antenna. These radio waves travel in straight lines at the speed of light (164,000 nautical miles per second). A radar transmits a short pulse then listens for th echo; this cycle may be repeated as many as 20,00 times per second or as few as 60 depending o the purpose of the radar set. Although rada systems vary according to function, there ar some characteristics and terms, which ar common to all and used in discussion concernin this equipment.

FREQUENCY

A characteristic common to all energy form (electrical, audio, heat, or visible light) is the manner of propagation. That is, they all prop agate in the form of traveling waves and as suc can be defined by their frequency and wavelengt The frequency, f, is expressed in cycles per secon (Hz) and is a measure of the number of complet oscillations that the wave exhibits in one secon (see fig. 10-1). The significance of frequency that the nature of the energy form (that is, hea light, electromagnetic) and its frequency ar directly interrelated.

WAVELENGTH

Wave motion is further described b wavelength. Wavelength is not simply defined a the distance between two identical points o adjacent waves (normally crests as shown in figu 10-1). For a traveling wave, it is also a measu of the distance by the wave during one complet cycle.

AMPLITUDE

A final characteristic of wave propagation the amplitude. This is defined as the displaceme at any point on the wave from a constant referen value, therefore it is a direct indication of the lev of energy at any point on a propagating wav The amplitude is normally thought of as bein solely a function of lateral displacement from th origin of the wave (see fig. 10-1).

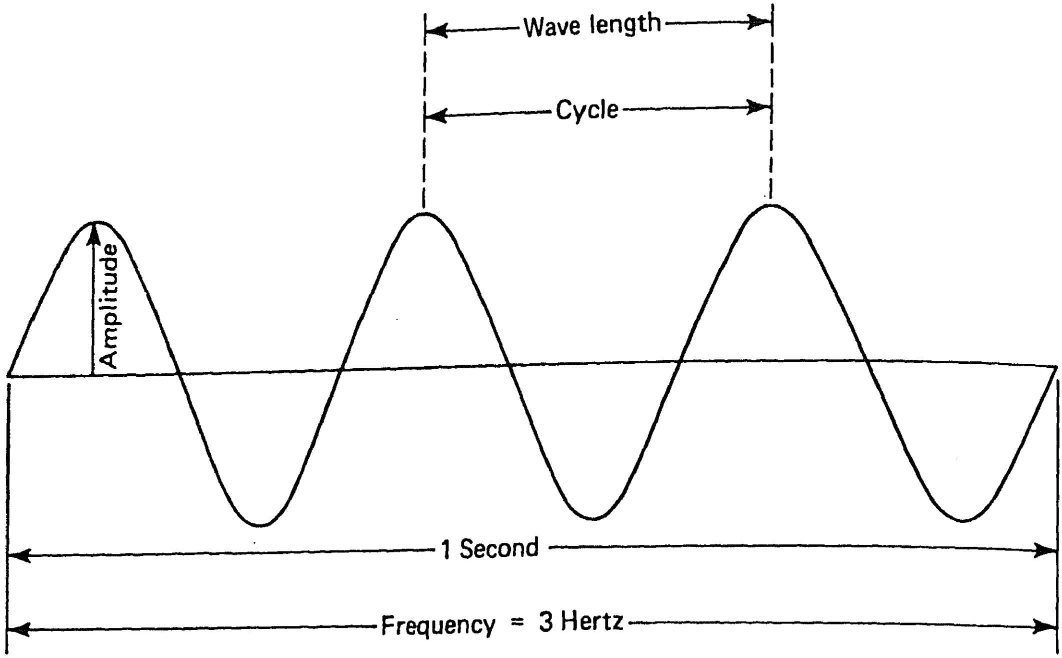

Figure 10-1.—Characteristics of a radio wave assuming a frequency of 3 hertz.

CARRIER FREQUENCY

Though much of the frequency spectrum could be used for locating and tracking objects, those frequencies just higher than those used for communications tend to work best. A radar's carrier frequency is the one which the equipment is operating on. This varies with the function of the radar; lower frequencies allow greater power output, and higher frequencies give better directivity. For those reasons air search radar, which require longer range, generally operate on lower frequencies than do surface search or missile control (or any weapon fire control) radars, which require finer resolution of direction.

PULSE REPETITION RATE

The pulse repetition rate (PRR) is simply the number of pulses sent out by a radar in a second (see fig. 10-2). As alluded to earlier an important consideration in setting the PRR is the radar range. Since the equipment "listens" for an echo from its pulse, the longer it listens, the greater distance the pulse may travel. Echoes that return after the next pulse is sent are obliterated. Therefore, given a high enough peak power (to allow echoes strong enough to be recorded) the PRR determines the radar's effective range.

PULSE WIDTH

Pulse width (PW), also called pulse length is the time (usually expressed in microseconds) that the radar set transmits a pulse (see fig. 10-2). This will determine a radar set's minimum range and the range resolution (the difference that must exist between two objects on the same line of bearing for the radar to note a difference between them). In one microsecond a radar pulse will travel 328 yards. The echo from this pulse cannot be received by the radar while it is transmitting. Thus as the pulse width of a radar increases, its minimum range will also increase. Normally for navigation a pulse time of approximately 0.1 microseconds is used, yet a long range radar may have a PW of up to 5 microseconds.

POWER

The power level of a transmitted pulse is referred to as the radar's peak power level (see fig. 10-2). When this is averaged over the pulse repetition time, the result is the radar's average power (see fig. 10-2). High peak power will allow longer ranging since echoes will be stronger—it will also allow detection by a passive receiver at a greater distance. Given receivers of the same

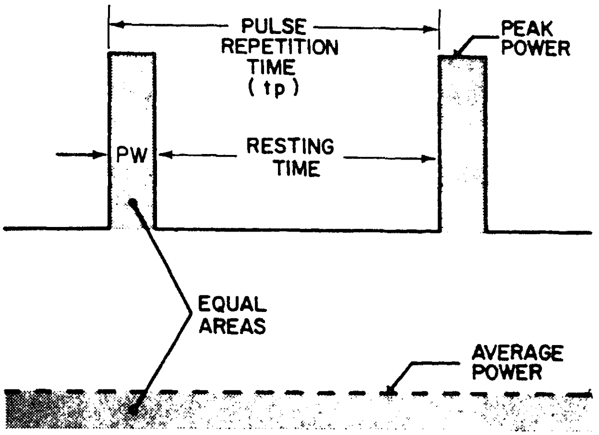

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Figure 10-2.—Radar pulse.

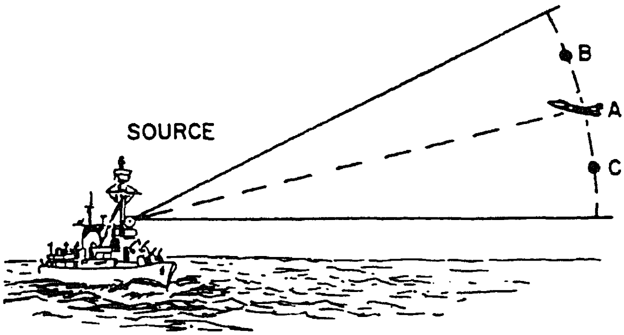
sensitivity, a radar may be detected at approximately twice the range allowed by its peak power level.

BEAM WIDTH

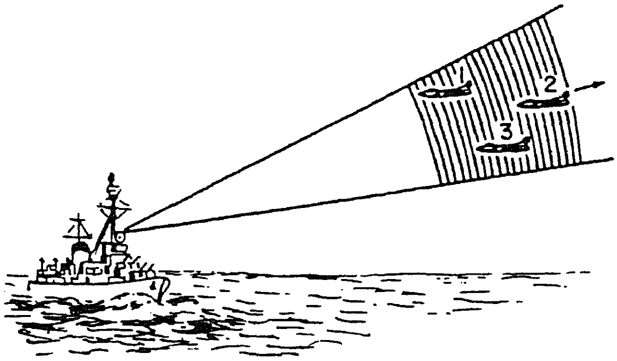
Beam width is the angle that is covered as the radar pulse is transmitted. The larger the angle the lower the resolution in bearing of the objects. As with other radar characteristics, the tactical use of the radar determines the beam width. When used for tracking or guidance, operations that require extreme accuracy, the radar beam must be narrow. A search radar, designed for initial detection would make use of a wide beam for the maximum probability of detection (see fig. 10-3).

CONTINUOUS WAVE RADAR

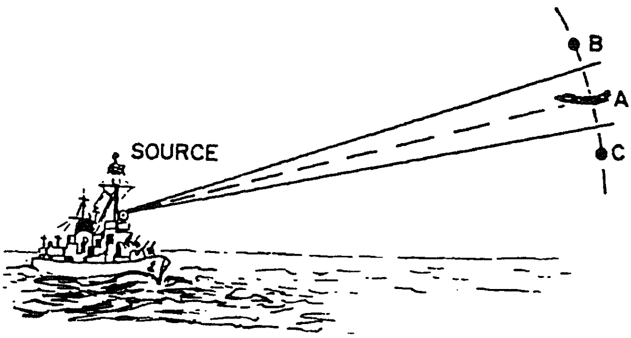
So far only pulse radars have been discussed; these provide ranging of objects by "listening" for



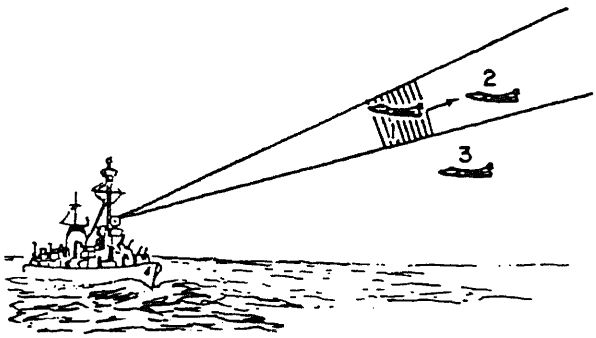
The airplane at A can move to B or C without producing a noticeable change on the radar viewing-screen.



A wide beam and long pulse produce an incoherent echo instead of separate echoes.



If the airplane at A moves to B or C, it can no longer be detected, unless the beam is moved.



Individual objects adjacent to one another can be detected if the radar set has a narrow beam and sends out a short pulse.

echo returns. There is also a radar type that transmits continuously with the echo received by a separate antenna; this is the continuous wave (CW) radar. CW radars are speed measuring equipment and listen for a frequency shift in the returning echo; this doppler shift is proportional to the object's velocity. Since there is no time reference, the distance to a contact cannot be determined. Yet a doppler effect radar can detect an object at near zero range and at its maximum power allowable range as it transmits and receives continuously.

RADAR FUNCTIONS

No one radar can be developed to accomplish all the functions of which these systems are capable since characteristics required for various situations are at times mutually exclusive. Missile control radars or those designed to assist accurate weapons firing (fire control) use high frequency to allow narrow beam widths which give high resolution. This gives very accurate bearings to targets, good object definition, allows the detection or pick-up of smaller targets, and also allows the use of a relatively small antenna.

In the use of a surface search radar, a high probability of initial detection coupled with accurate range and bearings are desired. A 360 degree search is conducted to reveal all objects within the radar's range, which is additionally limited (aside from its inherent characteristics) by the radar's horizon. Very high frequencies are used to get maximum reflection from small objects—allowing items as small as a submarine periscope to be "seen." These frequencies allow a narrow PW resulting in high resolution and range accuracy. Wide vertical beam widths compensate for a ship's pitch and roll, while narrow horizontal beam widths give the required accurate bearings.

Lone range air search radars are primarily for detection and a 360 degree search of air space (from surface to high altitude) is needed. Lower frequencies are used to prevent signal loss and a low pulse repetition rate allows maximum range (over 200 miles in some cases). A very wide vertical beam or an adequate substitute picks up high or low objects and a wide pulse width with high power detects small objects at the greater distances.

RADAR PHENOMENA

When a radiated electromagnetic wave encounters a conducting surface, reflection of energy from the surface occurs. This reflection follows the law of reflection; therefore the "bounce" will be at an equal angle with respect to the reflecting surface (see figure 10-4), as a beam of light would reflect from a mirror. Some incident energy is lost because of the presence of natural obstacles in the path of the radiation. Dust, snow, or water vapor will scatter radiation in a haphazard manner, resulting in a loss of beam power. However a far greater loss is encountered by irregularities in the conducting surfaces.

Refraction is the bending of a radiated beam as it travels through space. Earth's atmosphere is not a uniform medium, the density of the air at lower altitudes results in an increase in the index of refraction, which causes a downward bending of the radiated waves (see fig. 10-5). In bending the radar line of sight the horizon is slightly extended (as shown in fig. 10-5). It should be noted that the amount of this bending varies with the carrier frequency of the beam or pulse—higher frequencies bending much less than lower ones.

Numerous additional phenomena exist which affect radio waves and their propagation. Among these are skywaves—the bouncing of radio waves off the ionosphere thereby detecting objects over the horizon but leaving a "skip" area between you and the new maximum range that is not covered by your radar set. Groundwaves may extend your effective range, depending on the conductivity of the surrounding surface. These additional effects go beyond the scope of this discussion of basic radar operation, but they must be considered in the actual design and operation of today's sophisticated radar equipment.

AAW AND MERCHANT SHIPPING

In the past, the threat of serious damage to merchant shipping in a hostile environment from airborne weapons was minimal when compared to the danger posed by torpedo-firing submarines. The introduction of the cruise missile, with its capability for air, surface and subsurface launch, has changed the maritime threat environment. It is now and will continue to be the primary threat to surface ships. Regardless of the launching platform, once a cruise missile is fired, the target must have some form of AAW capability or protection to avoid severe damage.

In the remainder of this chapter we will look first at the Soviet Navy's ability to employ

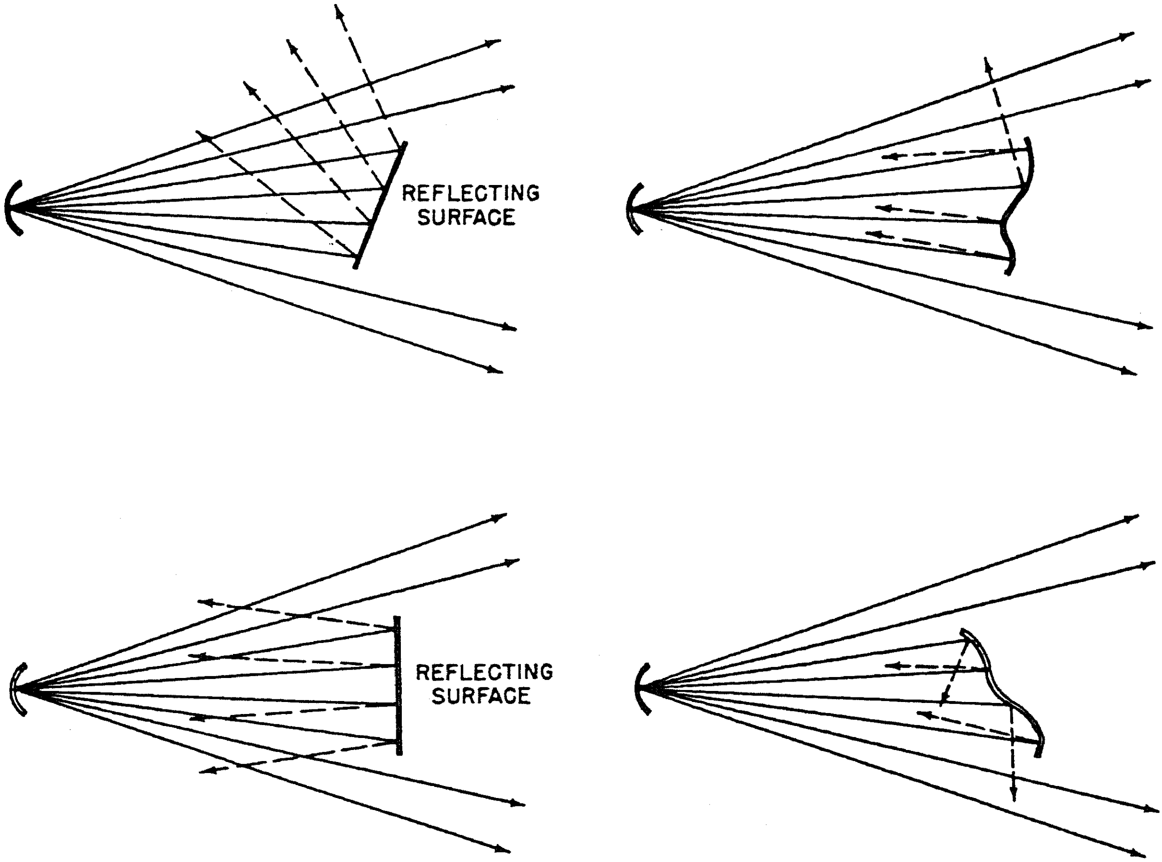


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Figure 10-4.—Reflecting surface dispersions.

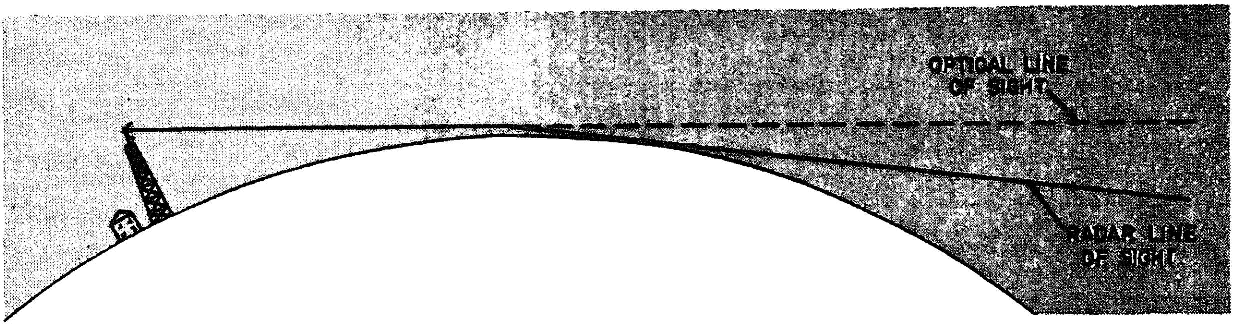

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Figure 10-5.—Extension of RADAR horizon as the result of atmospheric refraction.

cruise missiles against surface ships. Then the concepts of AAW and the U.S. Navy's capabilities in that area will be discussed.

THE SOVIET THREAT

The requirement for the U.S. Navy's extensive AAW capabilities stems from the possibility of having to deal with a major war in Europe and the threat of one in the Middle East with the accompanying task to ensure the sea lines of communication to these two theaters, the Mediterranean and the Persian Gulf, remain open. Soviet cruise missile and torpedo attack submarines are the principal threats to these sea

lanes. Of additional concern, in some areas, is the Soviet Naval Aviation forces and the capable fleet of Soviet surface combatants when it is within firing range.

Cruise Missile Submarines

Building on German experiments during World War II, both the U.S. and Soviet navies experimented with missile-launching submarines after World War II. The Soviet Navy developed cruise missile submarines in the 1950s for strategic attack and as part of a strategy to counter U.S. aircraft carriers.

In 1960, the first Soviet submarine launched antiship missile, the SS-N-3 SHADDOCK, became operational. The SS-N-3 is a large air breathing supersonic cruise missile with a range of approximately 250 miles. Initially, existing WHISKEY class submarines were converted to carry the SHADDOCK. Soon new submarines designed to carry the SS-N-3 joined the Soviet fleet. The diesel powered JULIETT class (carrying four missiles) and the nuclear powered ECHO II class (see fig. 10-6) were built from 1960 to 1968. These submarines must surface to launch. While surfaced they can receive targeting information from outside sources and then relay it, with the target indicated, to the missile in flight. During the 1970s an improved long range cruise missile was introduced, the SS-N-12 SANDBOX. Since then some units of the ECHO II class have been modified to carry the SS-N-12.

After producing 50 submarines of the JULIETT and ECHO classes, Soviet development turned toward short range missiles that could be launched while submerged. In 1968 the first CHARLIE I class SSGN (see fig. 10-7) was completed with the improved CHARLIE II following several years later. These nuclear powered submarines can fire eight 30 mile range SS-N-7 missiles (carried on the CHARLIE I class) or 60 mile range SS-N-9 missiles (carried on the CHARLIE II class). The underwater launch capability of the CHARLIE makes this craft one of the most potent antiship submarines in service today. When production ended in 1980, 17 units had been completed.

In 1980 the first of a new class of Soviet cruise missile submarines was launched. The OSCAR is a very large nuclear powered submarine carrying 24 SS-N-19 missiles. The SS-N-19 is an advanced cruise missile that combines the long range and supersonic speed of the SS-N-3/12 with the submerged launched capability of the SS-N-7/9. All of these cruise missile submarines also have conventional torpedo tubes.

SOVIET NAVAL AVIATION

The prime striking force of Soviet Naval Aviation consists of some 400 twin-jet bomber aircraft. These are fitted to carry one or two of several types of antiship cruise missiles that have "stand off" ranges varying from 100 to over 300 miles. In addition to naval aircraft, certain Tu-95 Bear (see fig. 10-8), and Tu-16 Badger bombers of Soviet long-range aviation can be used for

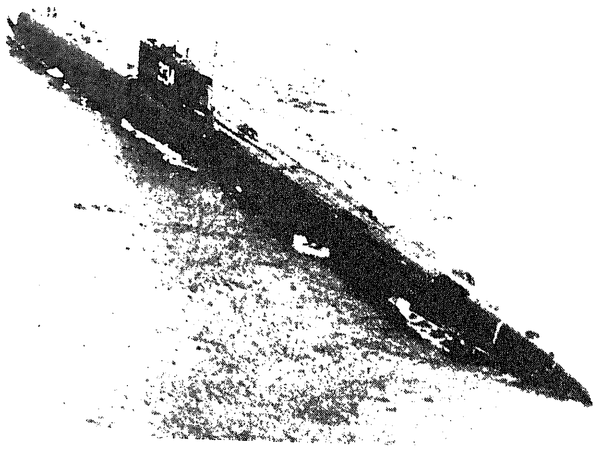

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Figure 10-6.—Aircraft and submarines armed with cruise missiles are the principal antiship forces of the Soviet Navy. The ECHO II with eight SS-N-3 missiles fired from the surface is nuclear propelled

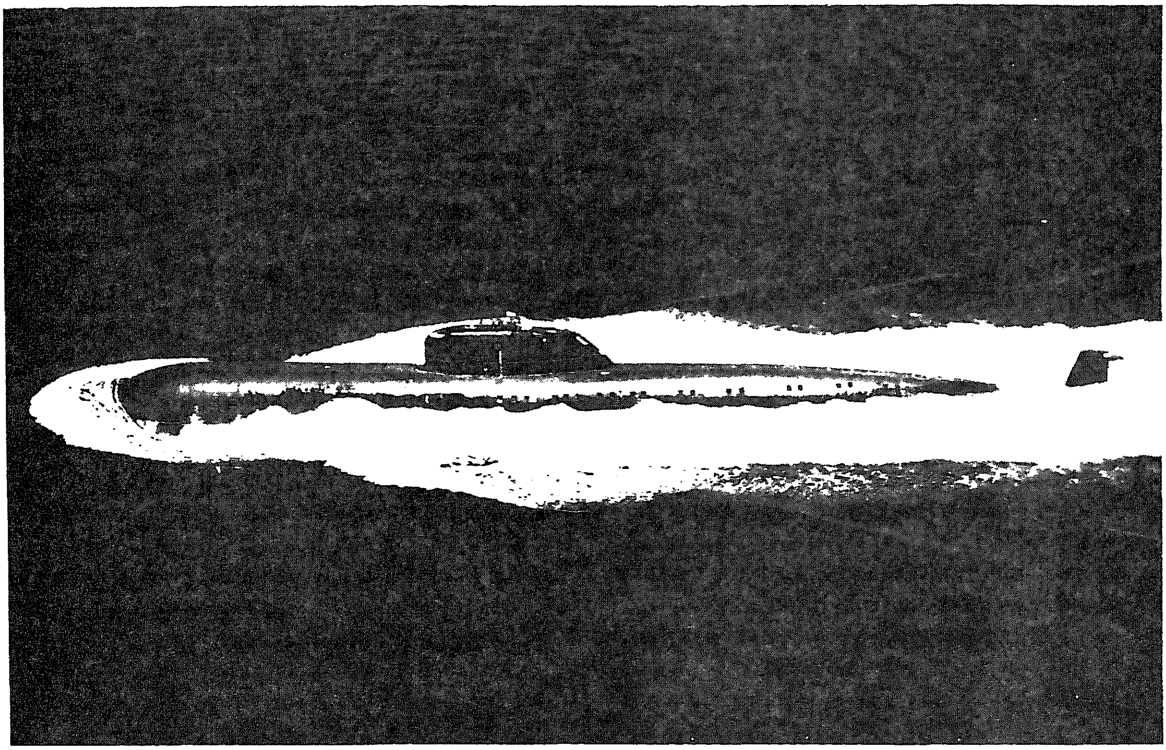

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Figure 10-7.—The CHARLIE-class, nuclear propelled, submarine has eight submerged-launch SS-N-7 missiles and can operate in virtually any ocean area.

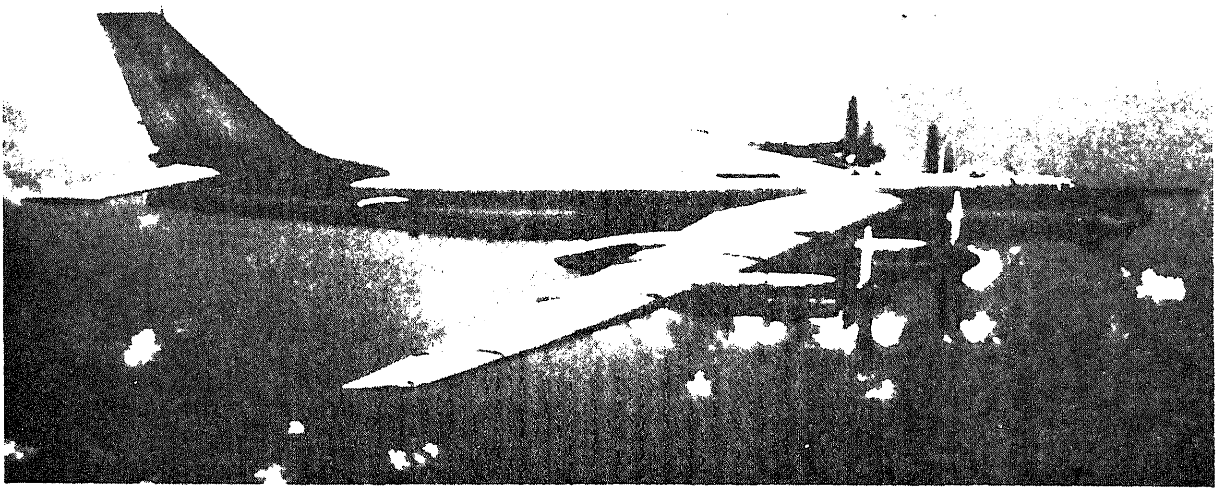

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Figure 10-8.—The Tu-95 BEAR D provides targeting information for Soviet air, surface, and submarine long range missile platforms.

attacks against shipping. These aircraft regularly participate in naval training exercises.

The principal aircraft employed by Soviet Naval Aviation (SNA) is the Tu-16 BADGER, a twin turbojet medium bomber that first entered Soviet service in 1954. Some 250 BADGER strike aircraft are in SNA, each capable of carrying one AS-2 KIPPER and two AS-5 KELT or two AS-6 KINGFISH missiles. Regiments of strike BADGERS are assigned to all four Soviet fleets.

Soviet Naval Aviation also flies the twin turbojet Tu-22M BACKFIRE, (see fig. 10-9), a supersonic aircraft with variable swing wings, which has been in SNA service since 1975.

The BACKFIRE's high speed (Mach 2 high altitude dash), long range, and ability to carry one or two AS-4 KITCHEN missiles make it a potent antishipping weapon. BACKFIRES flying from air bases in the Kola peninsula could attack naval and merchant shipping in the North Atlantic through an arc intersecting Gibraltar to the coast of Labrador. In the Pacific, BACKFIRES flying from Petropavlovsk could reach the Philippine Sea and western-most Hawaiian Islands. In-flight refueling could significantly extend these ranges. BACKFIRES flying from bases in the Crimea can cover the Mediterranean Sea.

The initial BACKFIRE regiments were assigned to the Baltic and Black Sea Fleets. In 1980 the first Pacific Fleet regiment was established. By 1983 some 100 BACKFIRES had been delivered to SNA. Production continues at a rate of 30 aircraft per year with half going to long range aviation and half to naval aviation.

The newest Soviet air launched antiship missiles are the rocket powered AS-4 KITCHEN and the AS-6 KINGFISH. These missiles are launched from medium altitude (20,000 to 35,000 feet), climb to a very high cruise altitude and speed (80,000 feet at Mach 3.0 to 3.5) and then dive steeply at their targets.

284.76

Figure 10-9.—The Tu-22M BACKFIRE B can attack shipping over much of the world's oceans. This aircraft is carrying

Soviet doctrine calls for coordinated attacks by missile armed aircraft and submarines, possible with surface ships participating in the attack if they can be brought within range of the target at the proper time. An antiship missile attack would include not only bomber aircraft with stand-off missiles but also reconnaissance and targeting aircraft, tanker aircraft and electronic countermeasure planes to help overcome enemy defenses.

The introduction of the KIEV class antisubmarine aircraft carrier with their YAK-36 FORGER aircraft may give the SNA another dimension of antiship capability. The FORGER is a small vertical take off and landing (VTOL) fighter plane that can be fitted with short-range air-to-surface missiles, bombs or rockets for use against ship or shore targets.

In 1981 a new Soviet long range, four engine, supersonic bomber began test flying. The BLACKJACK will probably enter service in 1986-87 and some may be assigned to the SNA.

SURFACE WARSHIPS

CRUISERS

Late in 1962 the Soviets sent to sea a new type of warship, the first KYNDA-class missile cruiser (see fig. 10-10). Like their U.S. contemporaries, the four KYNDA-class ships were armed with antiaircraft missiles, multipurpose guns, and antisubmarine weapons.

But most significant was the main battery of the KYNDAs: eight tubes for the SS-N-3 antiship cruise missiles and eight reload missiles in the ship's superstructure. With a maximum operational range of some 250 nautical miles, except for aircraft, the SS-N-3 is one of the world's longest-range operational weapons for use against ships. When fired at ranges beyond the horizon (about 25 miles), the SS-N-3 requires midcourse guidance. Still, the missile allowed a Soviet KYNDA to out-range every allied warship except for an aircraft carrier. Thus, Admiral Gorshkov of Russia attempted to counter the U.S. superiority in aircraft carriers with another type of warship rather than competing with the United States in a category where it had overwhelming superiority.

After producing the four KYNDA-class ships during the early 1960s, Soviet yards began turning out the KRESTA I in 1967. In this ship the Soviets reduced the number of long-range SS-N-3 launchers from eight to four, but increased the twin antiaircraft missile launchers from one to two and added a helicopter hangar. This permits the KRESTA to maintain a HORMONE helicopter on board. In the late 1960s and 1970s, Soviet ship development changed directions with all new large surface warships being primarily

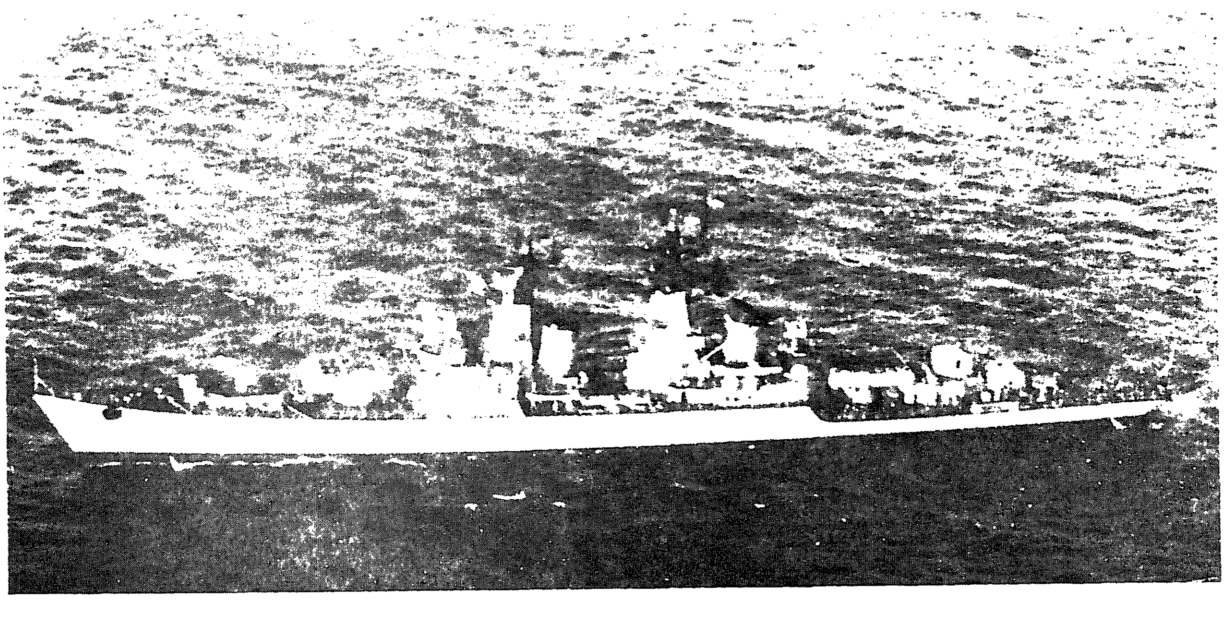

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Figure 10-10.—The KYNDA class cruisers were the first warships armed with long range antiship missiles. The quadruple

intended for ASW. Only four KEIV class ASW carriers are equipped with long range antiship missiles. The KIEV carries 24 SS-N-12 SANDBOX missiles.

In the 1980s Soviet production is again emphasizing antishipping capability. In 1982 the first of two KIROV class large cruisers joined the Soviet fleet. The *Kirov* is a heavily armed, nuclear powered ship equipped with 20 SS-N-19 missiles. In addition, the first of a new class of smaller conventionally powered cruisers armed with 16 SS-N-19 missiles began sea trials in 1982. The KRASINA class will carry many of the same systems as the larger KIROV class.

DESTROYERS

In 1960, the Soviet Union introduced the world's first guided missile destroyers. Four ships of this class, KILDIN, were built. The original armament included a quadruple launcher for the SS-N-1 antiship missile (maximum range 100 miles). In the early seventies two KILDIN class ships were modified. The quadruple missile launcher was removed and four single antiship missile launchers were installed for the newer SS-N-2C (45 mile) missile.

From early 1963 through 1967 Soviet shipyards delivered 20 KASHIN-class guided missile destroyers. They are armed with two large antiaircraft missile launchers, antisubmarine rocket launchers, five torpedo tubes, four 76-mm multi-purpose guns, and mine rails.

Their most distinctive features are four large funnels in tandem that indicate gas-turbine propulsion. These were the world's first large warships with gas turbines, and they give the KASHINs an estimated top speed of over 36 knots for brief periods.

Beginning in 1971, several KASHINs were modified in a manner similar to the KILDINs. Four SS-N-2C antiship missile launchers were added, which point aft in a half raised position for immediate firing. To date, six KASHINs have been converted.

In 1982 the *Sovremennyy* joined the Soviet fleet. It is the first of a new class of guided missile armed destroyers. In addition to its antiaircraft missile launchers and powerful gun battery, SOVREMENNYY is armed with eight SS-N-22 cruise missiles. The SS-N-22 is a new short range (60 mile) supersonic, low altitude missile. It is a follow on to the SS-N-7 and SS-N-9 series.

SMALL COMBATANTS

The Soviet Union operates more small combat craft—missile, torpedo, patrol, and mine craft—than the remainder of the world's navies combined.

Probably the most publicized of these craft are the OSA missile boats, which displace some 200 tons and are 130 feet long. Each OSA carries four launchers for the SS-N-2 STYX missile, which has a range of some 25 miles. The OSA II boats carry improved missiles that probably have a greater range. With a top speed of 34 knots and two rapid-fire, twin 30-mm gun mounts, the OSAs are potent ship killers. Over 120 OSAs are currently in Soviet service, and about 100 have been transferred to other navies (as have some 55 of the earlier, two-missile KOMAR missile boats).

The small size of the OSA obviously limits the craft's operating range and rough weather capabilities. In 1970 the Soviets introduced the *Nanuchka*-class small missile ship into service to overcome these limitations. The *Nanuchka* has a small SA-N-4 antiaircraft missile launcher forward and a twin 57-mm gun mount aft. The main battery consists of six tubes for the SS-N-9 missile. A modified version of this ship carrying four SS-N-2 missiles was recently sold to India.

A new hydrofoil missile boat, the *Sarancha* has been identified. This craft is smaller than the *Nanuchka* and mounts only four SS-N-9 missiles.

AAW ORGANIZATION

Because of the wide dispersion of modern formations and the rapidity with which the air picture develops, decentralization of control is the norm. The OTC usually delegates control of AAW efforts to a force antiair warfare commander (AAWC). The AAWC is responsible for coordinating all AAW measures including fighters, missiles, and guns. This person issues threat warnings and weapons restrictions if necessary. An important aspect of the AAWC's duty is to provide for the detection and identification of unknown air contacts and to ensure the safe movement of friendly aircraft within the AAW area.

If the AAW area is particualry large, the AAWC may wish to sub-divide it into smaller areas called sectors. Each sector is under the control of a sector antiair warfare commander (SAAWC).

SAAWCs control target engagement within their sectors and act in close concert with adjacent SAAWCs to ensure that targets that may be on a sector boundary or are crossing from one sector to another do not go unopposed.

When two or more ships are in company, a local antiair warfare commander (LAAWC) may be designated. The LAAWC coordinates the air defense of the group of ships and ensures that all units are kept informed concerning the AAW situation. In this way units such as auxiliary, amphibious, or merchant ships will not suffer because of their lack of sensors or communications equipment.

Each commanding officer is responsible for the defense of his ship. He must exercise initiative in using all the weapons at his disposal, including controlled aircraft, missiles, guns and electronic warfare. The CO must report the action he is taking to the AAWC, SAAWC, or LAAWC as appropriate. The AAWC will approve or disapprove; however, necessary action must not be deferred pending approval. This is known as control by negation and is normally the method used to control AAW action. Subordinates act on their own initiative and keep their superiors informed of what they are doing. If the superior does not approve of the action he will order the subordinate to stop. Otherwise he will say nothing. This method greatly reduces the amount of time required to respond to a threat and reduces the amount of information that must be communicated.

ANTIAIR WARFARE AREA

The antiair warfare area encompasses the total region to be protected from enemy air attack. The AAW area is divided into surveillance, destruction, and vital areas. (See fig. 10-11.)

The surveillance area extends from the center of the vital area to the maximum detection range of the most distant AAW unit (ship or aircraft). All appropriate sensors are employed to conduct search, detection, tracking, and identification operations.

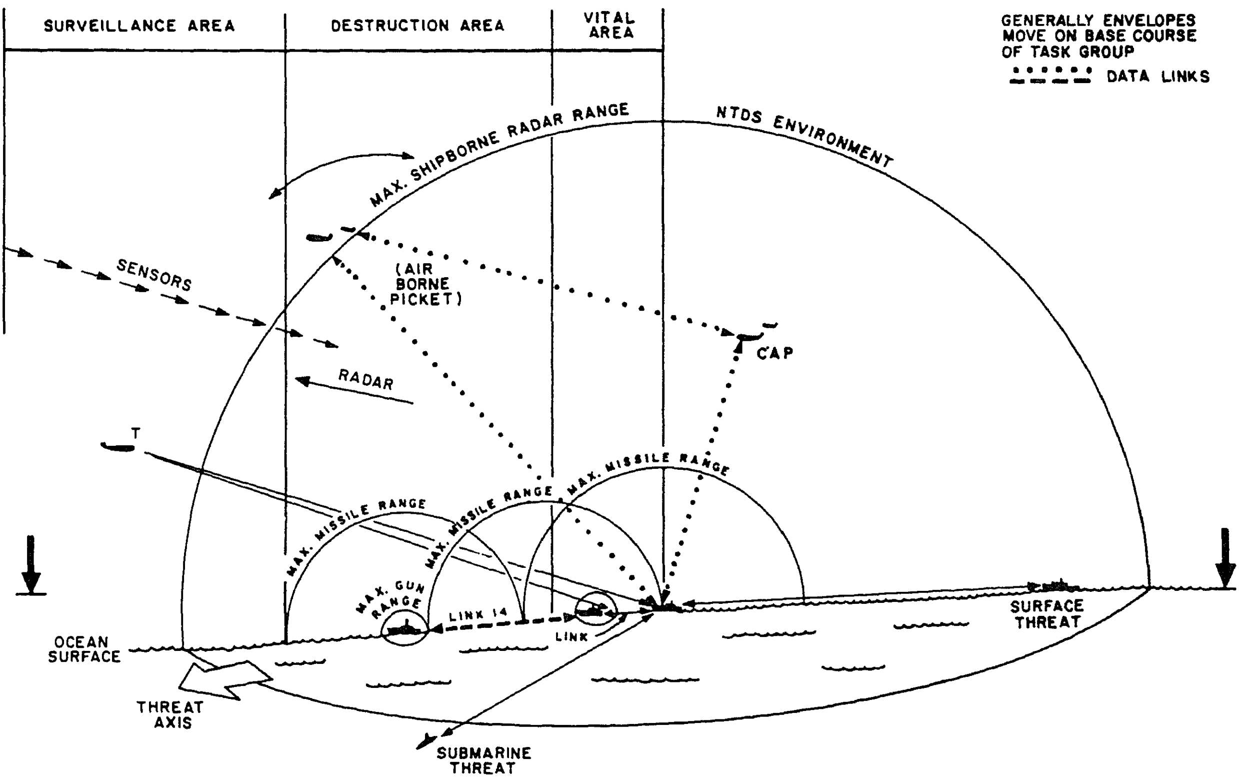

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Figure 10-11.—The antiair warfare area.

An AAW formation is based on the concept of destruction in depth, whereby enemy aircraft and missiles run a gauntlet of multiple air defense weapons systems. The destruction area may be divided into three zones, although there are no clear boundaries separating one from another. The zones are (1) aircraft intercept, (2) area defense surface-to-air missiles (SAM) and (3) point defense missiles and guns.

The vital area contains the unit or units on which the mission of the force depends. In the case of a convoy, the merchant ships would be within this area. The vital area must be defended to the maximum extent possible. Its outer limit is the estimated maximum range of the attacker's weapons. If at all possible, enemy missile platforms must be destroyed or driven off before they reach the vital zone and are able to launch their antiship missiles.

AAW PLANNING

Disposition (positioning of units) of modern naval force must be flexible to cope with multiple, perhaps simultaneous, threats. Not only must the degree of a particular threat be taken into account, but also the force's surveillance and engagement requirements. The best formation for surveillance may not be the best for defense against air attacks. A good air defense formation may present problems in defending against surface or submarine threats; the more widely a force is dispersed to meet nuclear weapon threats, the more difficult coordination becomes. Thus, flexibility is of prime importance.

STATIONING AIRCRAFT

Several factors influence the employment of fighter aircraft. Primary among them is the number of aircraft available. Other considerations include aircraft characteristics and weapons, and the need to destroy enemy aircraft before they reach their weapons release point. Fighter aircraft are either stationed as CAP under the control of a surface unit or AEW aircraft, or they are in a high degree of readiness aboard the carrier as deck launched interceptors to augment or replace airborne CAP. When the situation permits, both methods are used. CAPs are stationed beyond the missile zone in the direction of expected attack (threat axis) at altitudes that will provide the best chances of interception.

AEW aircraft are deployed along the threat axis well in advance of the force to provide the earliest possible warning of attacks. They usually will have CAP for protection.

When available, electronic warfare (EW) aircraft are also deployed. The primary mission

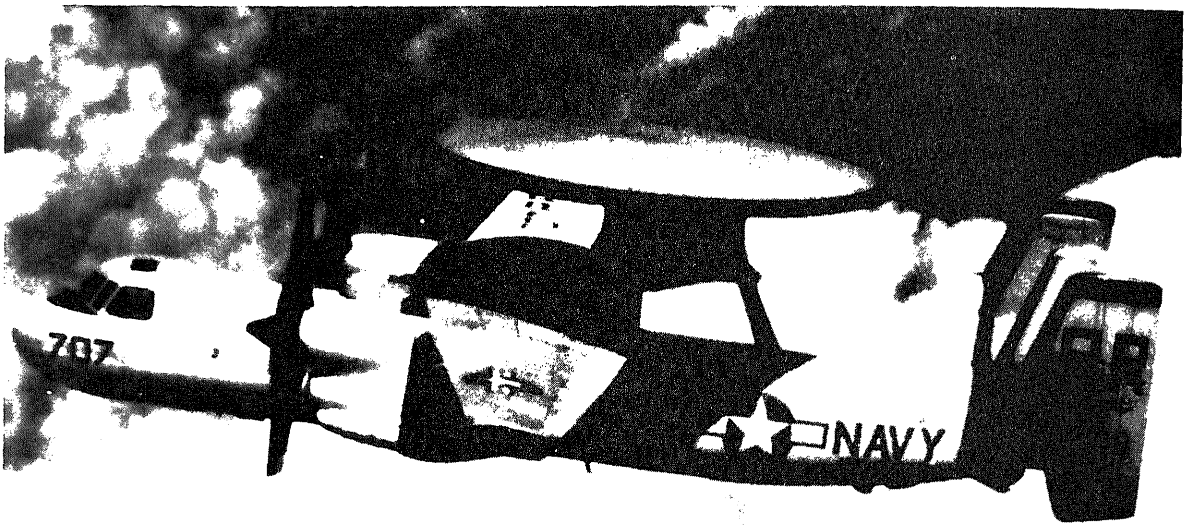

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Figure 10-12.—The E-2 HAWKEYE is the US Navy's carrier based airborne early warning (AEW) aircraft.

of EW aircraft is to protect surface and air units by jamming enemy radar and communications. The EA-6B *Prowler* can carry 10 jamming transmitters. Detection, identification, direction finding, and jamming may be performed automatically or manually.

STATIONING MISSILE SHIPS

Factors to be considered when stationing SAM ships include the number of ships available, threat priority, types of missiles, missile frequency interference, and ship capabilities (sensors, NTDS, ASW, and so on).

In addition to being stationed as pickets, SAM ships are positioned to protect the vital area and to provide mutual coverage for adjacent missile ships. Units should be deployed to meet an air threat from any direction and engage targets at maximum range. They cover all routes of approach, but they are more concentrated in the direction of the threat axis.

PHASES OF AAW

There are two major phases of an AAW operation: phase 1 is surveillance/detection; phase 2 is raid engagement. Phase 1 is a continuing function; it does not cease with the commencement of phase 2. If anything, surveillance and tracking operations are intensified during phase 2.

SURVEILLANCE

Timely warning of airborne threats is enhanced by employing outlying picket ships and airborne early warning (AEW) aircraft (see fig. 10-12). AEW aircraft are equipped with an airborne tactical data system (ATDS) that is capable of linking with the shipboard NTDS. They have a good low-flyer detection capability, can conduct air controlled intercepts, and act as a communication relay between the force and distant stations.

Picket ships, in addition to their surveillance function, control combat air patrol (CAP) aircraft to intercept raids as far from the main force as possible. A CAP consists of one or more fighter aircraft acting as a unit.

A special type of picket is the F-14 TOMCAT, which is stationed to one side of the threat axis. Friendly aircraft are required to pass over the TOMCAT station and be "deloused" by RAPCAP to prevent enemy aircraft from locating the force by following returning strike aircraft. (See fig. 10-13.) Additionally, the use of TOMCATS to identify friendly aircraft precludes their being designated CAP or missile targets. Any combatant ship or AEW aircraft capable of air intercept control may be assigned TOMCAT duties.

Early in the Vietnam conflict it became apparent that destroyers with conventional CICs could not cope with the high tempo of air operations. This difficulty was overcome with the development of the PIRAZ concept. A PIRAZ/SSS (positive identification radar advisory zone/strike support ship) unit is an NTDS-equipped missile ship that can simultaneously track, analyze, and display multiple air contacts and broadcast them over Links 11 and 14. Ships assigned PIRAZ/SSS duties are stationed well in advance of the main forces, often in close proximity to enemy territory. They positively identify all friendly aircraft, serve as navigational checkpoints for strike aircraft, control air intercepts, coordinate search and rescue operations, and perform other duties as may be required to ensure protection of the force.

The lookouts are not to be overlooked as part of the ship's surveillance system. Positive identification can be established only by visual means,

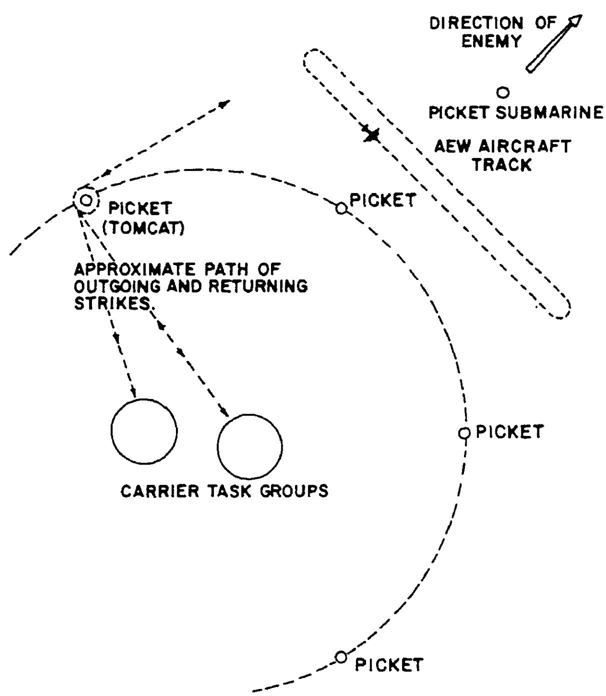

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Figure 10-13.—Attack carrier striking force disposition.

) lookouts must be impressed with their impor-
nce in furnishing information to the OOD
nd CIC. Under certain conditions of elec-
onic silence, lookouts may be the only means
f detecting enemy aircraft, particularly low
yers.

NGAGEMENT

When an air target is detected, it is evaluated
r its degree of threat. Elements that are
onsidered when assessing a threat include the type
f contact, its course and speed, time to reach its
eapons release line (WRL), time of flight from
RL to impact, and the number of contacts. Next
the process is determining what counters are
ailable to oppose the target, such as the type
d number of missiles remaining. The threat is
en assigned a priority in the preferred sequence
f aircraft, missiles, guns, and electronic
untermeasures.

In a conventional CIC, the foregoing processes
ke a considerable amount of time. With NTDS,
ey are accomplished almost instantaneously.

As soon as a contact is recognized as a threat, pertinent information is disseminated to the force over Links 11 and 14 and by radiotelephone over appropriate circuits. Such information includes track number, grid coordinates, course, speed, altitude, composition, and appropriate warning order, and weapons control order.

Fighter aircraft under the control of AEW aircraft or picket ships are a force's first line of defense against air attack. Fighters are stationed beyond shipboard missile range and are vectored to the most favorable attack position by air intercept controllers.

The current top fighter aircraft in the Navy is the F-14 TOMCAT (see fig. 10-14), which has a combat ceiling of over 55,000 feet and a maximum speed of over Mach 2. It can carry six PHOENIX long range missiles, which can be guided against six separate aircraft by the plane's AWG-9 weapons control system. For medium range combat, SPARROW and SIDEWINDER missiles are used, and the 20-mm Vulcan cannon is carried for short range attacks.

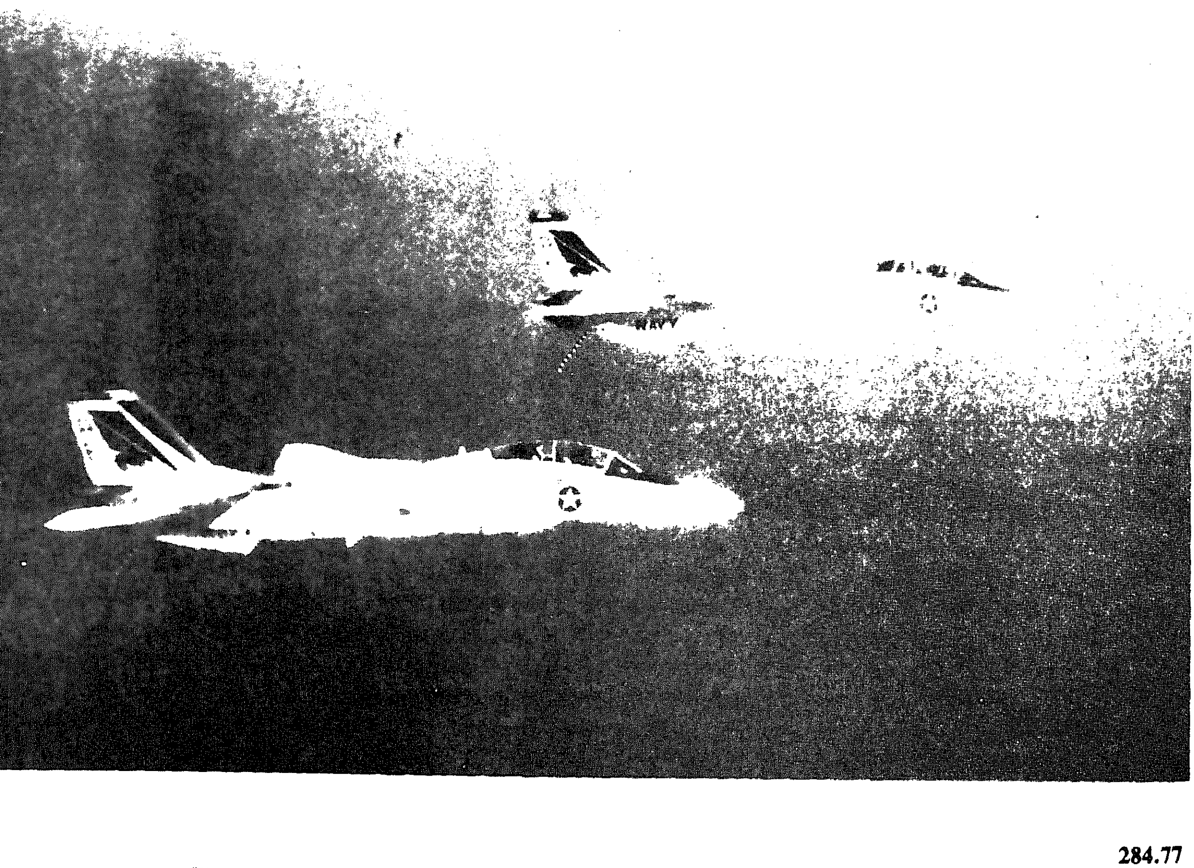

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Figure 10-14.—The F-14 TOMCAT fighter provides

Enemy aircraft or missiles which are not intercepted by fighters will next be engaged by surface-to-air missiles (SAM) fired by area defense ships (see fig. 10-15). Finally, any enemy missiles that leak through the outer defenses must be countered by individual ships using point defense systems, such as short range SAM, guns, and chaff.

COORDINATION

Each SAM ship has established around it a missile engagement zone (MEZ), a crossover zone, and a fighter engagement zone (FEZ). The ship is cleared to fire at any enemy target penetrating the MEZ unless negated by the AAWC. Friendly aircraft may penetrate a MEZ only when they are under positive control, in hot pursuit, or in a safety sector. In all cases clearance must be obtained from the AAWC. Safety sectors are established by the AAWC in terms cf length, direction, width, height, and time.

The crossover zone normally extends 15 miles beyond the MEZ, but it may be varied by the AAWC. Beyond the crossover zone is the fighter engagement zone. Fighters have freedom of engagement within the FEZ. When a missile is to be fired outside the MEZ, a missile arc is established. The arc is centered on the target's bearing and extends to the maximum range of the missile. All friendly aircraft are cleared from the missile arc.

The AAWC (or SAAWC) coordinates target engagement through issuance of warning orders, weapons control orders, and other directives. Warning orders are applicable to aircraft and/or missiles.

Warning Red—attack is imminent or is in progress. Hostile units are within an air defense sector.

Warning Yellow—attack is probable. Hostile units are en route toward an air defense sector.

Warning White—attack is improbable. All clear.

Weapon control orders are "Free" and "Tight." "Guns (weapons) free," means that fire may be opened on all aircraft not recognized as friendly. "Guns (weapons) tight," means do not open fire, cease fire, or cease fire on specified bogey or in sector indicated, unless the target is known to be hostile.

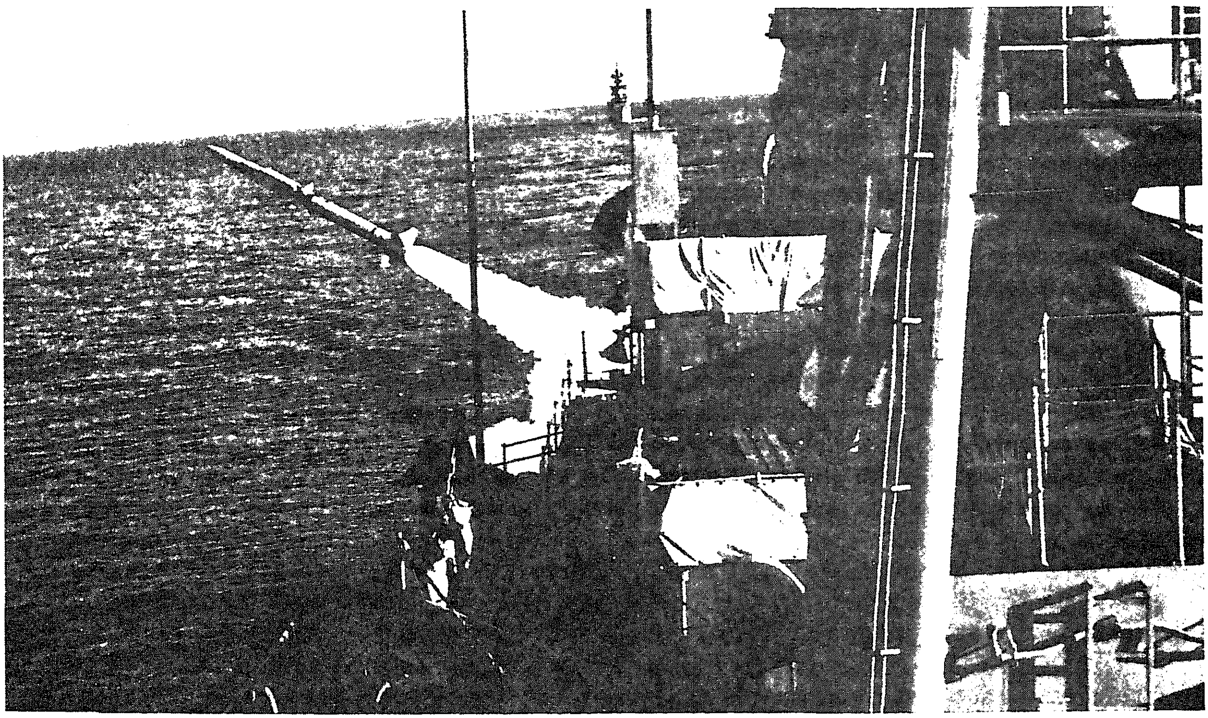

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Figure 10-15.—Surface to air missiles, such as this SM-1 ER being fired from the USS Dewey DDG-45, provide area defense against air attack.

By coordinating AAW operations, the AAWC inimizes mutual interference, ensures the safety fighters, and maximizes weapon effectiveness.

AAW WEAPONS

IR-TO-AIR MISSILES

Air-to-air missiles are the primary armament Navy fighter aircraft. The longest range eapon is the AIM-54 PHOENIX. The HOENIX is carried only by the F-14 TOMCAT. x of these 13 foot long missiles may be fired in pid sequence at six different targets. The missile designed to operate in a hostile electronic untermeasures environment without having its pability degraded.

The AIM-7 SPARROW is a medium range, dar guided missile. It can be carried by the F-14 OMCAT as well as the F-4 PHANTOM and the w F/A-18 HORNET.

The AIM-9 SIDEWINDER was our first -to-air homing missile. It is a short range, heat king missile that is carried by Navy fighter and ack aircraft.

RFACE-TO-AIR MISSILES

Area defense is provided by guided missile isers, destroyers, and frigates equipped with ious forms of standard missile systems. ndard missiles (SM) are a development of the lier TERRIER and TARTER programs. There two basic SM versions; the single stage dium range (MR) and the two stage extended ge (ER) missile. The SM-1 MR has a range 25 miles, while the SM-1 ER has a range 40 miles. Cruisers and destroyers are now ng modified to employ a new model of the ndard missile, the SM-2. This weapon has atly increased range and ships equipped h SM-2 can engage multiple targets ultaneously.

Point defense is provided by SPARROW ssiles modified for shipboard use in the Basic int Defense Missile System (BPDMS). An proved version, named NATO SEASPARROW, ow being installed on carriers, destroyers, high ue auxiliary, and amphibious units as well as ps of allied navies. Although SEASPARROW designed to protect individual ships against craft and missile attacks, it also has limited use inst surface targets.

Guns

Guns are a ship's final defense against air attack. Guns also provide defense against surface attack because they are dual-purpose (DP) weapons systems.

The 5"/54 (5-inch bore, 54 calibers, or bore diameters, long) automatic rapid-fire DP gun is carried by virtually all post-World War II destroyers and cruisers. The 72-pound shell has an effective range of about 12 miles.

Most auxiliaries and amphibious force ships carry 3"/50 semiautomatic guns in twin mounts. Rate of fire is 45 rounds per minute per barrel; range is about 7 miles. Many of these weapons eventually will be replaced by others, such as Phalanx.

The new FFG-7 class ships carry the Oto Melara 76-mm, 62-caliber rapid-fire DP gun. Because of its light weight, the gun is also

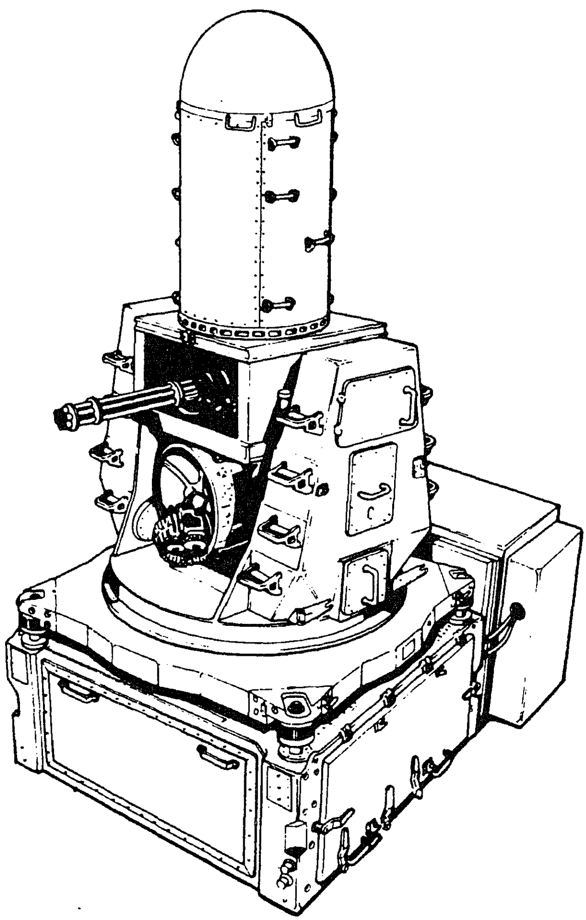

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Figure 10-16.—The Phalanx close-in weapon system.

suitable for installation on missile hydrofoil boats. It has a firing rate of 85 rounds per minute and a range of about 9 miles.

Scheduled for the most widespread installation is the Phalanx close-in weapon system (CIWS) (see fig. 10-16), which is designed as a ship's last ditch defense against antiship missiles. The system is a complete unit containing search and tracking radar, a fire control system, the 20-mm, six-barrel Vulcan Gatling gun, and a magazine. Its firing rate is 3000 rounds per minute.

Although not a weapon system, the super rapid bloom offboard chaff (SRBOC) is part of a ship's defense against missile attacks. When fired, the chaff acts as a decoy to the enemy missile, drawing it away from the ship. Spruance class destroyers, cruisers, auxiliaries, and amphibious ships will have four, six-tube launchers. FF and FFG vessels will have two, six-tube launchers. (Further information on CHAFF is provided in chapter 14.)

Both the PHALANX and the CHAFF systems lend themselves to installation on U.S. controlled merchant ships in time of war or national emergency as they are modular in construction and strictly defensive in nature.

CHAPTER 11

ANTISUBMARINE WARFARE

The purpose of antisubmarine warfare (ASW) operations is to deny the enemy the effective use of its submarines. In the early years of World War II, German submarines nearly caused the defeat of England. Success for the Allies came only with the development of new equipment and weapons and the perfection of suitable tactics. Conversely, in the Pacific areas, the Japanese Navy never achieved lasting success in its defense against the U.S. Navy's submarine force, which practically destroyed Japan's merchant marine. Obviously, the degree of proficiency of ASW actions was a key factor in both situations.

Basically antisubmarine operations are either offensive or protective actions. Offensive actions include air strikes against submarine bases, building yards, and search attack unit operations. Protective actions include convoy escort, screen, and area and harbor defense operations. Other operations, such as minelaying and search and patrol, may be either offensive or protective in nature.

A submarine's effectiveness depends on its ability to remain undetected. Since the principal method of submarine detection is sonar, we will discuss sound propagation in the sea. We will also discuss ASW units and general ASW operations.

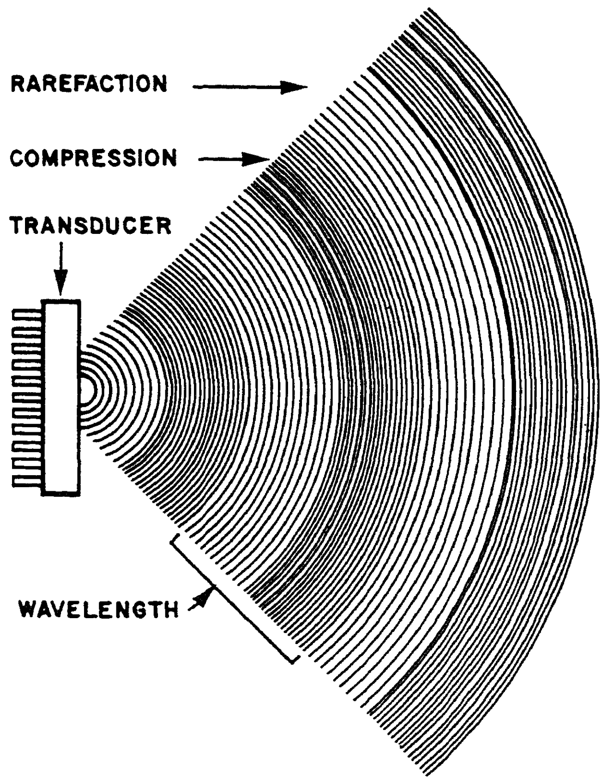

Figure 11-1.—Longitudinal waves.

SOUND WAVE PROPAGATION

Sound waves are longitudinal (compression) waves set up by a vibrating object; in this case, the sonar transducer. When the transducer vibrates, it produces areas of alternately high and low pressure or compression and rarefaction (fig. 11-1). As the waves travel outward, they spread with the result that wave energy becomes weaker with distance. Sound wave velocity varies from 4,700 to 5,100 feet per second, depending on sea conditions.

TRANSMISSION LOSSES

Three factors are directly related to sound transmission losses: divergence, absorption, and scattering. The latter two are attenuation losses and are dependent on transmission frequency. Divergence loss is independent of frequency.

Divergence

When a sound wave is projected from a point source, it assumes a spherical shape, spreading equally in all directions. This spreading is

alled divergence. The energy lost because of pherical divergence is inversely proportional to he square of the distance from the source.

In shallow water the surface and the bottom imit vertical divergence with the result that the xpanding wavefront is cylindrical rather than pherical. Cylindrical spreading loss is inversely roportional to the distance from the source.

ttenuation Losses

As the sound wave moves through the water, nergy is lost in the form of heat with each ompression and rarefaction. Energy lost in this nanner is called absorption loss.

Composition of the sea varies from place to lace and from time to time. In general, however, eawater contains large amounts of minute articles of foreign matter and many kinds of narine life of all shapes and sizes. Each time a ound wave meets one of these particles, a small mount of the sound is reflected away from its lirection of movement. These reflection losses are alled scattering losses.

NVIRONMENTAL EFFECTS

The speed of a sound wave and the path, or aths, it follows are controlled by three conditions f the sea: temperature, pressure, and salinity. emperature has the most effect; pressure, the east.

emperature

Temperature is by far the most important of he factors affecting the speed of sound in water. s the temperature increases, so does the speed f sound. For each 1 °F rise in temperature the peed of sound increases 5 feet per second.

ressure

Sound travels faster in water under pressure; hus, the deeper a sound wave travels, the faster t travels. For each 100-foot increase in depth, the peed of sound increases about 2 feet per second.

alinity

Salinity has a lesser effect on the speed of ound than does temperature, but it has greater han that of pressure. In the open ocean, salinity alues normally lie between 30 and 35 parts per housand. In the region of rivers emptying into the sea, salinity values often approach zero. For each part per thousand increase in salinity, the speed of sound increases about 4 feet per second.

Composite

Figure 11-2 shows reasonably normal curves for temperature, salinity, and pressure as a function of depth in the Pacific Ocean and also the resulting velocity structure. Please note that the salinity variation plays a minor part in the form of the depth velocity curve. This effect is almost entirely evident in the first 500 feet below the surface. The temperature curve also shows wide variations in the top 500 feet. From 2,000 feet downward, the temperature is nearly uniform as the water approaches the maximum density point at about 40 °F. The pressure effect is represented by a straight line as the velocity increases linearly with depth.

On the composite curve, it easily can be seen that the velocity in the top 2,000 feet is a somewhat skewed replica of the temperature curve. Below 2,000 feet it follows closely the straight line gradient of the pressure curve.

Depth/Temperature Effect

Except at the mouths of great rivers where salinity may be a determinant, the path followed by sound is governed by the water temperature and the pressure effect of depth.

The pressure effect is always present and always acts in the same manner, tending to bend the sound upward. Figure 11-3 illustrates the situation when the temperature does not change with

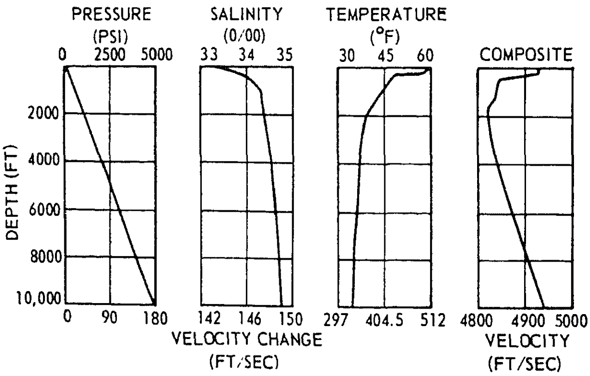

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Figure 11-2.—Normal curves for pressure, salinity, and temperature.

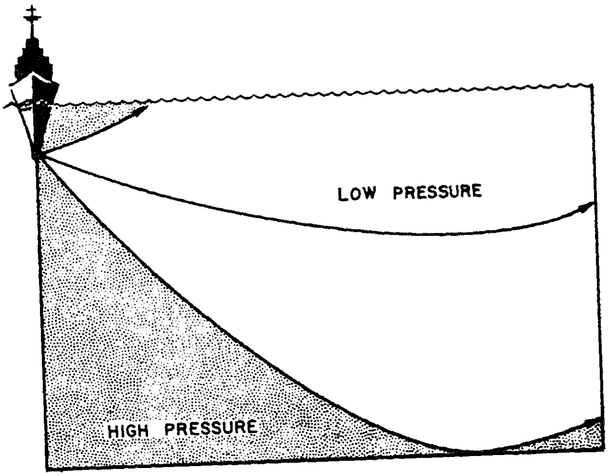

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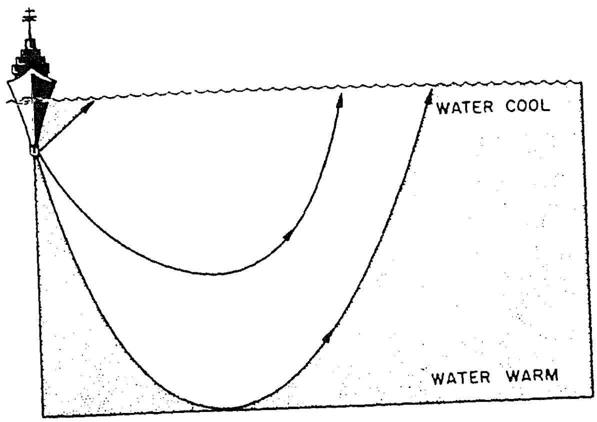
Figure 11-3.—Pressure tends to bend the sound beam upward.

depth. Even though the temperature does not change, the speed of sound increases with depth (because of the effect of pressure), and the sound bends upward.

Figure 11-4 shows what happens when temperature increases steadily with depth. When the surface of the sea is cooler than layers beneath it, the water has a positive thermal gradient. Although this condition is unusual, it does happen and causes the sound to be refracted sharply upward. In certain areas of the Red Sea, for example, temperatures of well over 100 °F have



71.30

Figure 11-4.—Positive thermal gradient tends to bend the sound wave upward.

been recorded in depths exceeding 1 mile. Moreover, the salinity of the water in those area approaches 30 percent, compared to between percent and 4 percent in most ocean areas.

When the sea grows cooler as the dept increases, the water is said to have a negativ thermal gradient. Here the effect of temperatur greatly outweighs the effect of depth, and th sound is refracted downward. This commo condition is illustrated in figure 11-5.

If the temperature is the same throughout th water, the temperature gradient is isotherm (uniform temperature). In figure 11-6, the upp

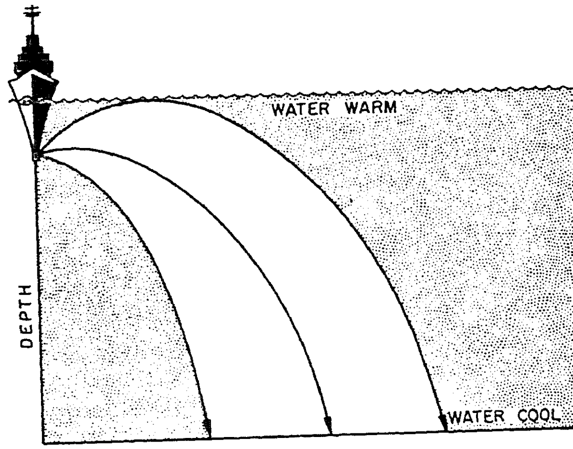


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Figure 11-5.—Negative thermal gradient tends to sound downward.

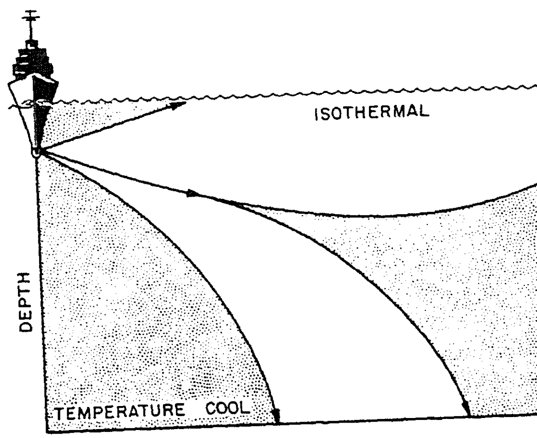

Figure 11-6.—Sound wave splits when temperature form at surface and cool at bottom.

ıyer of water is isothermal: beneath this layer the :mperature decreases with depth. This :mperature change causes the transmitted sound › split and bend upward in the isothermal layer ıd downward below it.

Under ordinary conditions the sea has a :mperature structure similar to that in figure l-7. This temperature structure consists of three ırts: a surface layer of varying thickness, with ıiform temperature (isothermal) or a relatively ight temperature gradient; the thermocline, a :gion of relatively rapid decrease in temperature; ıd the rest of the ocean, with slowly decreasing mperature down to the bottom. If this structure ıanges, the path of a beam of sound through ıe water also changes.

ayer Depth

Layer depth is the depth from the surface to e top of a sharp negative gradient. Under ›sitive gradient conditions, the layer depth is at e depth of maximum temperature. Above layer :pth, the temperature may be uniform. If it is ›t uniform, a positive or weak negative gradient ay be present.

ayer Effect

Layer effect is the partial protection from echo nging a submarine gains when it submerges :low layer depth. On the ASW ship, ranges on bmarines below a sharp thermocline are reduced eatly. If echoes are received from a submarine below layer depth, they often are soft and mushy.

Shallow Water Effect

Echo ranging is difficult in shallow water because the sound is reflected from the bottom. When the ship is in shallow water and the ocean floor is smooth, the sound bends down from the surface to the bottom then back up to the surface, and again down to the bottom. When the transmitted sound acts in this manner, there are spaces empty of sonar coverage into which a submarine can pass and be undetected.

The shaded spaces in figure 11-8 are called shadow zones. As shown in the illustration, contact is made at long range (point A), is lost (point B), and is regained (point C). Note that without the reflection, maximum contact range would be point C. The reason for loss of contact at short range (point D) is that the submarine passes beneath the sound wave. This distance depends on the depth of the submarine. A rule of thumb for estimating a submarine's depth is, the range in yards at loss of contact is roughly equal to the depth of the submarine in feet. A contact lost at 300 yards would thus be presumed to be about 300 feet deep.

DEEP WATER SOUND PROPAGATION

From the preceding discussions, it can be concluded that the behavior of the sound wave is influenced considerably by the structure of the sea. Most of our discussion so far has pointed out the adverse effects on a sound beam in comparatively shallow water—say 100 fathoms or

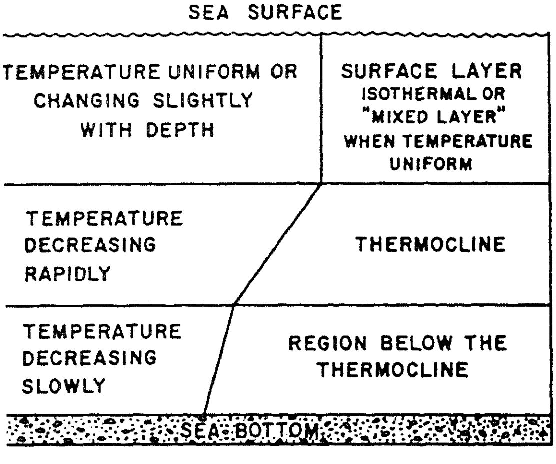

Figure 11-7.—Typical layers of the sea.

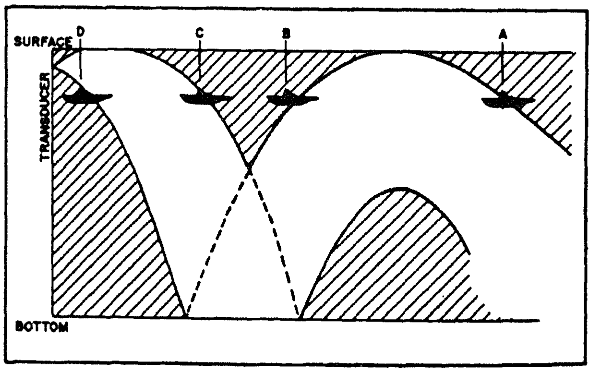

Figure 11-8.—Shallow water effect on transmitted sound.

less. Now, let us examine some of the phenomena that take place in very deep water.

Direct Path

Theoretically, if the sound waves were not affected by velocity gradients, all the sound waves would be straight lines and would travel in a direct path at whatever angle they left the source. In actual practice, however, the sound beam follows a path, or paths, as determined by the sea condition at the time.

Sound Channel

Figure 11-9 illustrates a combination of two gradients of equal slope, one negative and one positive. Their junction is a point of minimum velocity. If a sound source transmits at this depth of minimum velocity, all of the sound beams that start in an upward direction will be bent back down, and those that start downward will be bent back up. When such a condition occurs, we have a sound channel. The depth of minimum velocity is the axis of the channel. In this symmetrical situation, a beam that starts out downward will rise as high above the channel axis as it went below it, and then will be bent downward again. Sound will remain in the channel as far as the channel exists, and it will suffer very little loss as it progresses through the channel.

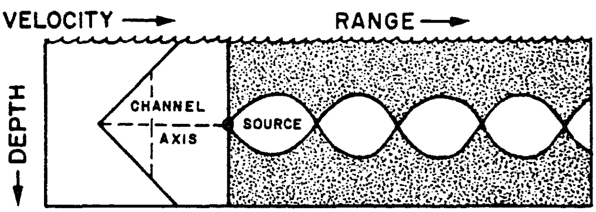

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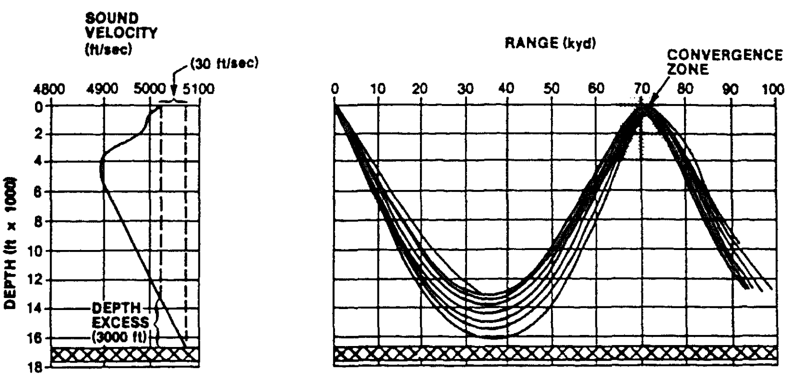
Figure 11-9.—Strong negative and strong positive gradients forming a sound channel.

Although sound channels are a rarity in shallow water (under 100 fathoms), they are always present in the deep water areas of the world. The depth of the axis of the channel is about 350 fathoms in the central Pacific and somewhat over 500 fathoms in the Atlantic. In the polar regions where the surface water is materially colder, the axis of the channel lies nearer the surface.

Convergence-Zone Propagation

Certain conditions of sound velocity structure and water depth can cause sound rays to be focused within a particular region (called a caustic) and produce a sharp increase in sound level. A caustic at or near the surface has traditionally been called a CZ (illustrated in fig. 11-19). CZs usually occur in deep, mid-latitude waters that have a negative gradient overlaying a positive gradient. For a CZ to occur, the sound velocity at the ocean bottom must exceed the maximum sound velocity in the negative gradient near surface layer by at least 30 feet/second. With many deep SVPs, a 30-foot/second excess in sound velocity equates to approximately 3,000 feet in depth excess. In other words, CZ propagation can be expected if the ocean bottom depth is at least 3,000 feet deeper than the depth at which the sound velocity is equal to the maximum near-surface sound velocity. (See fig. 11-10.)



284.78
Figure 11-10.—Convergence-zone propagation.

Caustics can also appear at below-surface lepths, even when surface CZ conditions are not atisfied. When the sound velocity at the sub- narine depth satisfies the depth excess require- nent, a caustic can occur at the submarine depth. Vhen a negative gradient is overlaying a positive ;radient and the depth excess requirement can be .chieved, a caustic will be formed; the strength of the caustic is proportional to the magnitude of the velocity gradients (strong gradients create trong caustics).

NOTE: In submarine sonar applications, austics formed below the surface have been istorically referred to as CZs. When there is a eep caustic but no surface CZ, the deep caustic ıay be referred to as a *deep CZ* to avoid onfusion.

Seasonal changes in the sound velocity tructure affect the amount of depth excess ırough changes in the near-surface velocity. CZ onditions tend to occur most frequently in winter ecause of the lower surface temperatures. In deep 'ater (12,000 feet), the range of a CZ is primarily function of the near-surface sound velocity. In orthern latitudes, the CZ range typically varies ·om 15,000 to 40,000 yards. Because of warmer ırface temperatures in mid-latitudes, the CZ ınges are typically from 50,000 to 70,000 yards. Iultiple CZs commonly occur in deep open-ocean reas.

The CZ focuses the sound into a narrow band f ranges from the sound source; the distance ·om the edge of the CZ closest to the sound ›urce to the edge furthest from the sound source referred to as CZ width. The CZ width is ›pproximately 10 percent of the distance from the ıbmarine to the middle of the CZ. In a plan view, ıe CZ appears to be a ring or annulus with a width equal to the CZ width. At frequencies below 100 Hz, the CZ width increases because of the reduced refraction effects on low-frequency sound.

Bottom Bounce

For long range search in water depths over 1,000 fathoms, newer sonar equipment may operate in a bottom bounce mode. The transducer is tilted downward at an angle so that the sound beam strikes the bottom and is reflected back to the surface, as shown in figure 11-11.

Because of the depression angle (15° to 45°), the sound beam is affected less by velocity changes than are sound pulses transmitted in the normal mode. At great depths (2,500 fathoms and greater), however, the sound beam usually will be refracted before reaching the bottom, thus producing a convergence zone effect.

BATHYTHERMOGRAPH

Information about the ocean temperature at a given time can be used to predict what will happen to transmitted sound. Because thermal conditions are of the utmost importance, a means must be available for determining water temperatures at various depths. Such a means is the bathythermograph (BT).

From BT measurements conclusions can be made concerning the maximum range at which a submarine may be detected, as well as the most favorable depth for a submarine to avoid detection. These considerations are important in antisubmarine warfare: they influence the type of screen used and they aid in determining ship spacing in the screen.

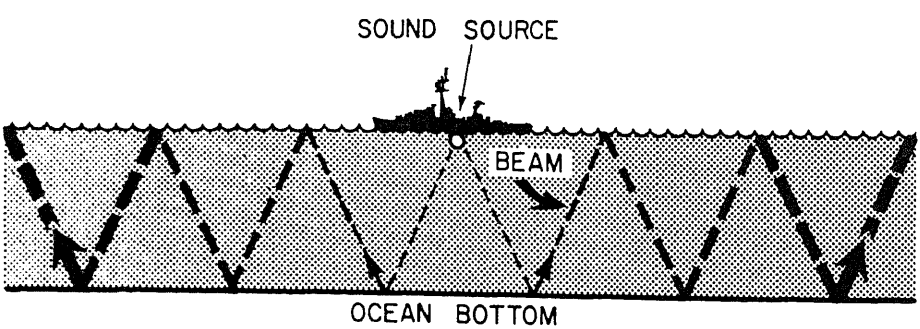


Figure 11-11.—The bottom bounce effect.

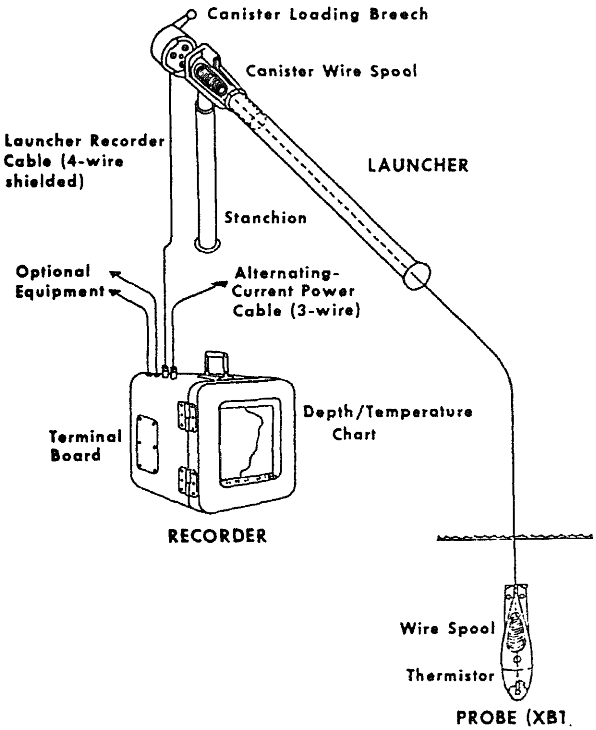


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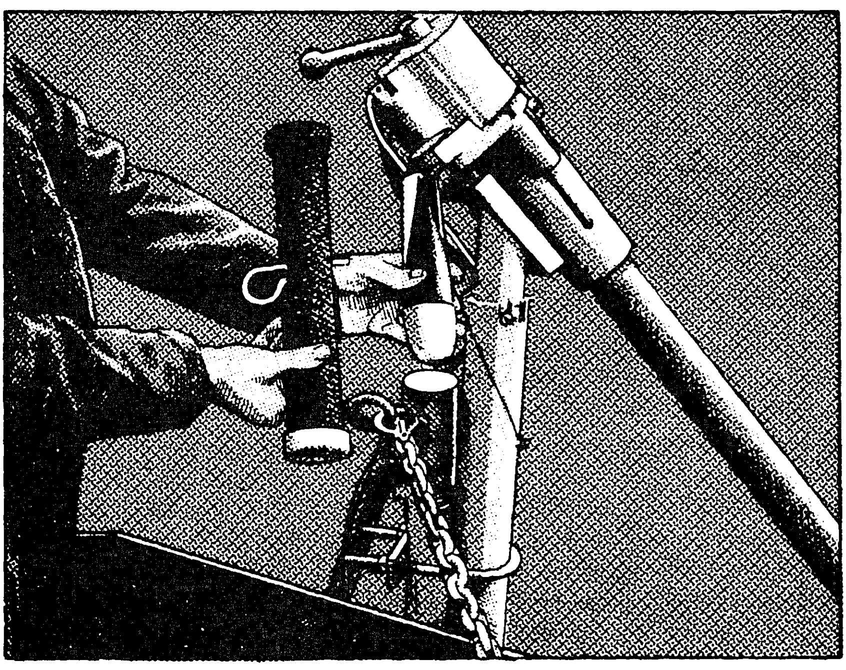
Figure 11-12.—Expendable BT system.

The surface ship expendable bathythermograph (XBT) system (fig. 11-12) has a sensor probe, a canister, a launch mechanism, and a temperature-depth recorder. The expendable portion of the system, consisting of the canister and the probe, is shown in figure 11-13. The probe weighs about 1 pound and is spin stabilized. It contains a thermistor, which senses temperature changes, and a reel of special wire. The canister also contains a reel of wire. The launcher can be installed to provide through-the-hull launching of the probe, eliminating the necessity for personnel to be on deck in rough weather. The recorder plots a track on a strip chart of temperature versus depth in real time. The strip chart is synchronized to the probe's rate of descent.

Operation

When the canister with the probe is placed in the launcher, an electrical connection is formed that sets automatic starting circuits in the recorder. When the probe is launched, wire begins to unreel from both the probe and the canister. This double unreeling action allows the probe to sink straight down regardless of ship speed.

As the probe strikes the water, an electrode sends a signal that activates the recorder which



71.127

Figure 11-13.—Expendable components and launcher.

ɪlots temperature readings from the thermistor. ⱡt a depth of 1,500 feet, the probe's wire is ·xhausted and the recorder stops. A complete eadout is obtained in 90 seconds from time of aunch. Temperature range of the probe is 28 °F o 96 °F with an accuracy of 0.4 °F. Depth .ccuracy is 2 percent, or 15 feet, whichever is ;reater.

ℓecorder Traces

From the temperature curve, one can discover he sound pattern of the sea at the time of the ꞁT observation. It is from the sound pattern hat an estimate of maximum sonar range can be ɿade.

The variation of temperature with depth can ·e quite complicated. Many different conditions ɿay be represented by the different types of :aces.

A negative gradient condition exists when the temperature decreases with depth, and the BT recorder trace will appear as in figure 11-14. Negative gradients, which are quite common, cause short sonar ranges.

A positive gradient exists when the temperature increases with depth. Although usually found in coastal waters, this condition may be observed anywhere. Figure 11-15 shows a positive gradient down to a certain depth, beyond which a negative gradient is formed. As a result of this condition, little of the sound pulse's power penetrates the negative gradient. The higher temperatures in the lower part of the positive gradient bend the sound beam upward toward the surface where it is reflected downward again, and so on, forming a surface channel within which unusually long sonar ranges may be obtained. Any energy that penetrates the negative gradient is reduced greatly, and the sound beam bends

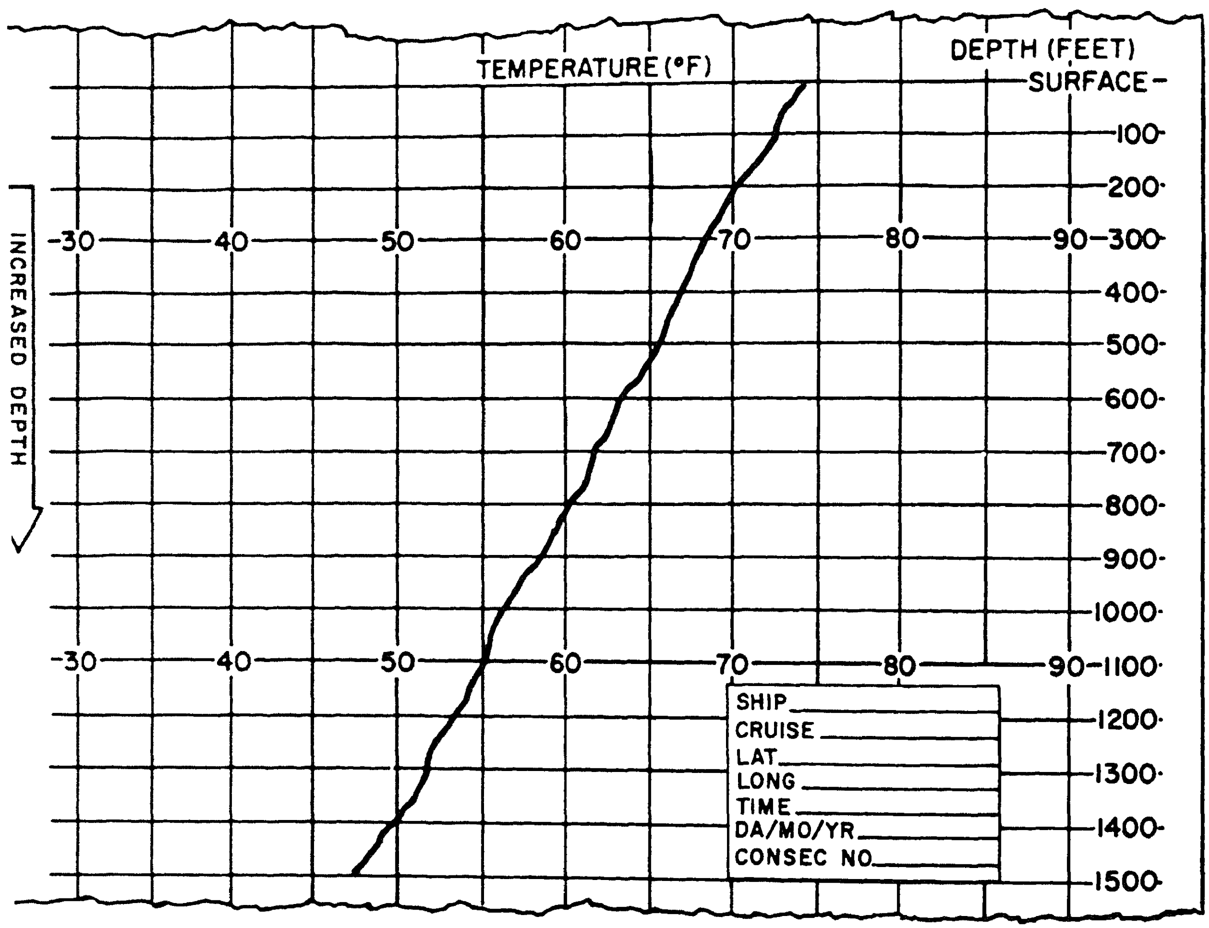


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Figure 11-14.—Negative gradient.

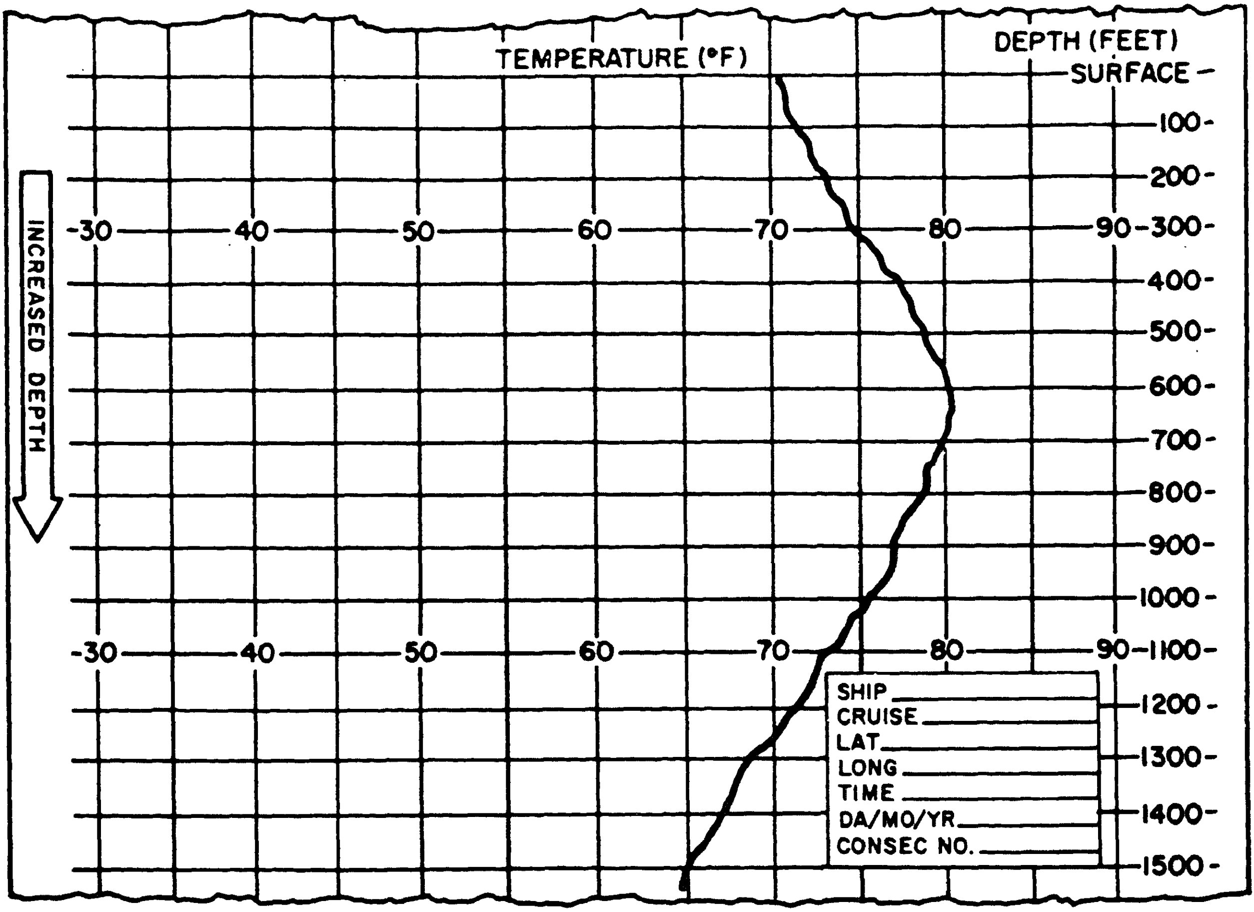

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Figure 11-15.—Positive gradient.

sharply downward. Submarines operating below this layer are very difficult to detect.

THE SUBMARINE THREAT TO MERCHANT SHIPS

The effectiveness of submarines against merchant ships in wartime was demonstrated in both world wars. During World War I, 4,837 merchant ships were sunk by a German submarine force that never exceeded approximately 120 U-boats. In the little more than two years preceding the entrance of the United States into World War II, German U-boats were again concentrating on the destruction of merchant shipping. By October 1941 Britain was in desperate straits, its maritime lifelines slashed by the U-boat offensive. During the first 10 months of 1942, the Battle of the Atlantic was in the balance. In this period the submarines dealt their hardest blows and Anglo-American losses totaled approximately 800 ships—better than four million tons. At the same time, the U-boat force lost 78 submarines, a high price for the success they were never again to equal.

In the Pacific, overall U.S. submarine strategy called for a war of attrition against Japanese merchant shipping. As the attrition war developed, target priorities were altered and submarines launched an all-out offensive against the Imperial Navy, simultaneously conducting a blockade against Japan. Japanese shipping was the crux of the war situation—transports to support and maintain the offensive and merchant fleets to exploit the conquered territories, support the home economy, and supply the war machine.

As early as January 1942, Pacific Fleet submarines were sinking ships off the coast of Japan. The American submarine offensive began

o hit its stride in 1943. Japanese losses amounted o 284 ships, more than one million tons. During 944, Japanese merchant shipping was all but lecimated. Some 494 ships were sent to the ottom by submarine torpedoes—a total of over wo million tons. By the end of the year, the apanese home empire was facing a rice famine, var industries were scraping the bottom of the arrel for vital ores and chemicals, and the mperial Navy and Air Force were out of oil. inkings in 1945 were superficial as the enemy's nerchant marine was reduced to a point where here were few vessels at sea to sink. By he spring of 1945, Japan's economy was uined.

The present is never an exact replica of the ast, and no two wars are ever alike. It would ppear, however, that on balance, submarines still ave the upper hand against surface ships.

SUBMARINES: ADVANTAGES AND DISADVANTAGES

In comparing submarines with the ASW orces, we find that submarines have certain dvantages, and the ASW forces have certain dvantages over the submarines. We will point out ubmarine advantages and then discuss the ASW orces advantages.

As seen by the ASW forces on the surface, the ubmarine has the following advantages:

1. Concealment. The submarine is concealed hen submerged and is hard to detect because of s low silhouette even when surfaced. A snorkeling submarine or a submarine at periscope depth visible to a surface or airborne observer and hows up on radar; but if the sea surface is at all gitated, such detection quickly becomes marginal r impossible. Except in certain unusually ansparent ocean areas (in localities of the Pacific nd Caribbean, for example), a completely ubmerged submarine is totally invisible to the urface or airborne observer armed only with ptical aids and radar. It can be detected by sonar, ut this method has limitations.

2. Personnel. Submarines have more highly ained and developed personnel, both physically nd professionally. In virtually all the navies in e world, submarine personnel are selected for eir superior potential and proficiency, and they ceive more training in submarine operations an the average naval officer or enlisted person ceives in ASW.

3. Passive detection capabilities. Because submarines are so hard to detect, ASW forces must search actively for them, and in the two chief methods of searching, they reveal themselves to the submarines. A radar pulse from a searching ASW vessel can be detected by a sensitive electronic countermeasure (ECM) receiver at a much greater range than that at which a submarine's silhouette (or its even less obtrusive antenna, periscope, and snorkel) will return a definite echo. This is particularly true when weather is poor or the sea surface is agitated. A sonar pulse similarly can be heard by a submarine much beyond the maximum range at which the sonar will produce a reliable echo. Lastly, although a submarine snorkeling or on the surface can be seen by surface or airborne observers, usually an observer in the low-lying submarine will see the observer first.

4. Immunity to surface water. A submerged submarine avoids the buffeting of rough surface winds and waves.

5. Reduced noise production. Other things (such as type of listening gear, screw rpm, or speed through the water) being equal, a submarine listening at moderate depth will probably hear a surface vessel before the surface vessel can hear the submarine. At present, the main reason for this is cavitation produced by rotation of the ship's screws in the water. As water pressure increases, cavitation and the noise it produces decrease. A submerged submarine is under greater pressure because of its depth; hence it produces less cavitation noise. It is also true that an electric drive inherently is likely to be somewhat quieter than a steam turbine or diesel plant, and that conventional submarines generally run at lower speeds submerged than they do on the surface, so that they tend to be quieter even without taking cavitation into account. Hydrodynamic investigation indicates that the bow wave (the *bone in a ship's teeth*) produced by hull movement on the surface is inherently more wasteful of power, hence noisier, than movement of water around a *tear drop* type of hull structure completely submerged in the water. Nuclear-powered boats, which have steam-driven turbines, do create more underwater noise than the electrically driven conventional submarines. Speed and depth capabilities partially compensate for this, however. It seems relatively safe to predict, therefore, that the noise-detection advantage that submerged submarines now have is likely to continue in the future.

longer hold a speed advantage over the submarine.

Not all the advantages are with the submarine. In the following respects, the ASW forces have the advantage:

1. Vulnerability. Even relatively slight damage to a submarine can force it to surface—relative, that is, to the damage required before a surface ship is put out of action. Slight damage that does not force it to surface may increase its noise output (for example, it may be necessary to start pumps because of a leak) and give its position away to listening observers.

2. Personnel endurance. This is limited by the physical conditions of life aboard a submerged submarine, particularly of the less advanced types, and the combined psychological and physical strains to submarine personnel under attack, even when the attack is not lethal.

3. Number. ASW forces are generally concentrated so that more than one ship plus aircraft attack a submarine. In theory, two or more submarines can work together in an attack, but any attempt at communication between the submarines will give away their position, destroying the submarines' main advantage. Moreover, even though communication between ASW forces is relatively easy (by radio, flashing light, and so forth) and cannot be detected by submerged submarines, communication between submarines is at best likely to be garbled and difficult, as well as tactically disadvantageous.

It is apparent that submarines still possess the capability demonstrated in both world wars, to defeat the ASW forces and sink merchant ships. The threat that this capability might be used in the future against American merchant ships comes primarily from the Soviet Union.

THE SOVIET THREAT

The Soviet Navy long has been a world leader in operating submarines. Beginning in the late 1930s, the Soviet Navy generally has had more undersea craft than any other navy.

Today, the Soviet submarine force numbers approximately 380 units. (Another 100 units are

- Torpedo attack submarines—submarines that attack an enemy surface ship or submarine using only torpedoes.

- Cruise missile submarines—submarines that fire antiship missiles as well as torpedoes.

- Strategic ballistic missile submarines—submarines armed with long-range, nuclear missiles for striking strategic land targets.

The Soviet Navy is operating a total of about 150 nuclear-powered submarines compared to some 110 in the U.S. Navy.

Attack Submarines

The Soviet Navy operates approximately 210 attack submarines. Most are diesel-electric powered, and many are of recent construction. About 60 of the torpedo attack submarines are nuclear powered, being of the November, Victor, and Alfa classes. The Alfa is believed to be among the fastest (40+ knots) submarine in service today. An improved Victor III class is now in production, while prototypes for what may be more advanced classes (Sierra and Akula) have been observed. The Soviet Navy continues to build diesel-powered submarines, the Foxtrot class for overseas sale (India and Libya), and the new Tango class. Soviet writers have noted that diesel-electric submarines offer a quiet-running, highly capable platform which can operate in shallower waters than the nuclear-powered boats and at a fraction of the construction cost.

The prime weapons of these attack submarines are antisubmarine and antiship torpedoes, but mines also can be carried. The newest submarines have a rocket-propelled ASW weapon as well.

Cruise Missile Submarines

The threat from this type of submarine has been discussed in chapter 10, "Antiair Warfare," because the cruise missile represents an incoming airborne target to be dealt with by a surface ship. Remember, however, that all classes of Soviet submarines are equipped with torpedo tubes and thus are always a subsurface threat regardless of their primary mission.

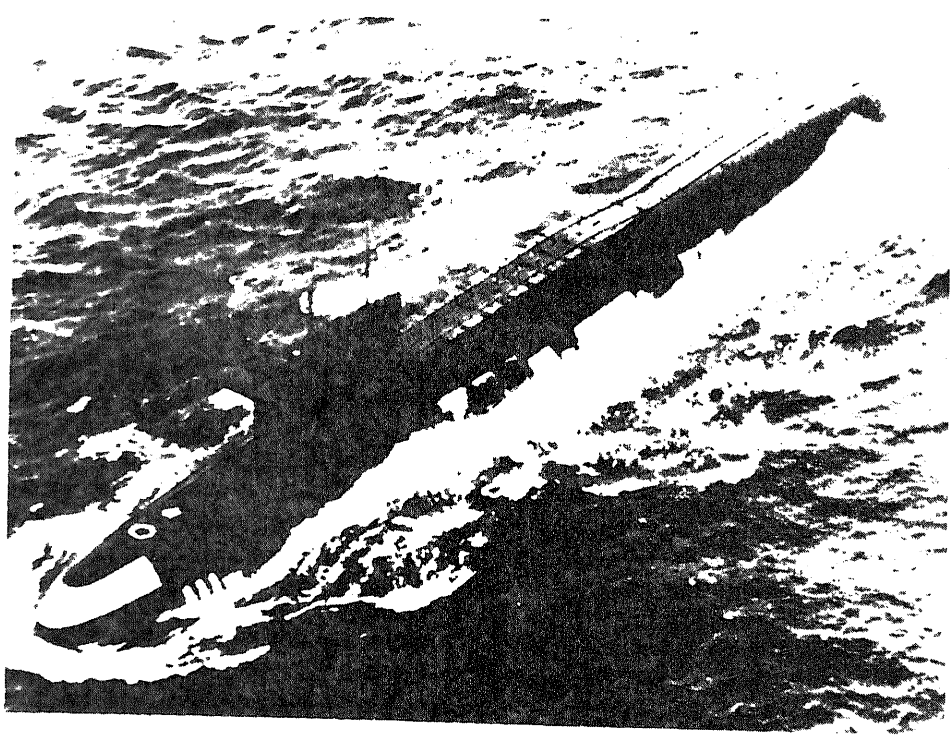
allistic Missile Submarines

The development of nuclear weapons led to 1other role for the submarine, that of strategic : ballistic missile attack against land targets. ubmarines are valuable in this role because the fficulty of their detection in the ocean depths akes them highly survivable against hostile tack.

As discussed earlier, the Soviets began nverting existing diesel-powered submarines in e mid-1950s to fire short-range submarine unched ballistic missiles (SLBM). Then, in the rly 1960s, the Golf-class diesel and Hotel-class iclear SLBM submarines were completed. These bmarines were limited by mechanical difculties, short-range missiles, and the requirement r surfacing to launch their missiles. (Most of ese submarines were later provided with a bmerged missile launch capability and improved eapons.)

Today, the Soviet Navy has an SLBM force at already exceeds that of the U.S. Navy in imbers of submarines and in missiles. By the end of 1974, the Soviet Navy had 34 of the Yankee-class SSBNs in service (fig. 11-16), each carrying 16 nuclear-tipped missiles with a range of at least 1,300 nautical miles (later increased to about 1,600 miles). During 1973 the first of the larger Delta-class submarines was completed. The early Deltas displace some 9,000 tons submerged and have an overall length of about 450 feet. The Delta I has 12 tubes for the SS-N-8 missiles. A total of 18 Delta I's have been built. The Delta II carries 16 SS-N-8 SLBMs and is about 50 feet longer than the Delta I. There are only 4 Delta II's. The Delta III carries 16 SS-N-18 missiles and is 8 feet shorter than the Delta II, but it has a larger missile casing to accommodate the larger and longer range SS-N-18. To date 14 Delta III's have been deployed. As of January 1985, the Soviets have built the world's largest submarine. Two units of Typhoon class have been added to the Soviet ballistic missile submarine fleet. The Typhoon is 600 feet long by 75 feet wide and carries 20 SS-NX-20 missiles.

The Soviets have produced an advanced version of the SS-N-8, designated the SS-NX-18,



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ure 11-16.—The 34 Yankee-class strategic missile submarines completed since 1967 were the "second generation" Soviet SSBNs. More than 20 years later DELTA I/II submarines and a still more advanced SSBN, the Typhoon class, are now at sea. An intensive submarine missile development effort has accompanied their construction.

which is a liquid-fuel missile capable of ranges of 4,300 nautical miles. This missile is the first Soviet SLBM to have multiple independently targeted reentry vehicles (MIRV), with as many as three of seven warheads that can be aimed at separate targets. The SS-NX-18 is more accurate. The SS-NX-17 is another advanced missile, apparently developed as a replacement for the SS-N-6 in the Yankee class. It is the first solid propellant SLBM built by the Soviets. The SS-NX-17 uses a post-boost vehicle that would allow it to carry a MIRV package. This new missile will probably have increased accuracy and range capabilities compared to the SS-N-6.

Submarine Construction

The Soviets have led the world in the production of submarines in the post-World War II period. Since the end of the war, Soviet shipyards have built over 600 submarines (compared to about 150 for the United States).

Of particular significance has been the Soviet emphasis on nuclear-powered submarines. The Soviet Union has completed more and larger nuclear-powered submarines than the United States.

The Soviet Union maintains a large submarine construction capability which they continue to expand and which is now being used at less than 50 percent of its estimated capacity. Submarines are produced in five building yards in the U.S.S.R., while presently only two U.S. yards are constructing submarines. The huge shipbuilding complex at Severodvinsk on the White Sea could well have a greater nuclear submarine building capacity than the combined nuclear submarine building capabilities of the United States, Great Britain, and France.

Over the last several years, the Soviets have constructed about 10 new submarines a year. Of the Soviets active submarine fleet, half are nuclear-powered. Of these new construction units, 30 percent are nuclear-powered ballistic missile carriers (SSBN), 40 percent are designed as nuclear-powered ASW platforms (SSN), while the remaining 30 percent are battery-diesel powered platforms (SS). The latter platform is used to support fleet use and sales to foreign countries. By contrast, the U.S. has built an average of about three nuclear-powered ASW platforms (SSN) per year; this total will increase to five or six per year as the new Los Angeles SSN production peaks during the next several years.

The Soviets have constructed both diesel and nuclear-powered submarines that can launch cruise missiles, while the U.S. Navy is now beginning to deploy the Harpoon missile in submarines and is developing a submarine-launched Tomahawk. The Soviets have also developed a weapon similar to the U.S. Navy's SUBROC, an underwater-launched missile that flies a relatively short trajectory and carries an antisubmarine torpedo or depth charge.

The Soviet submarine force continues to be the dominant branch of the Soviet Navy. Although the total number of submarines has been slowly decreasing as older diesel craft are retired, the numbers of nuclear-powered and missile-armed submarines continue to increase. (See fig. 11-17.) Thus we see that the Soviets now have in operation a large number of submarines, both nuclear and diesel. It is reasonable to suppose and realistic to anticipate, that ASW forces opposing them will find the Soviet submarine and its weapons far from backward technologically.

U.S. NAVY ANTISUBMARINE WARFARE UNITS

Although submarines, particularly the attack type (SSN), are capable of antisubmarine operations (often that is their primary mission), our discussion of ASW units is limited to ships and

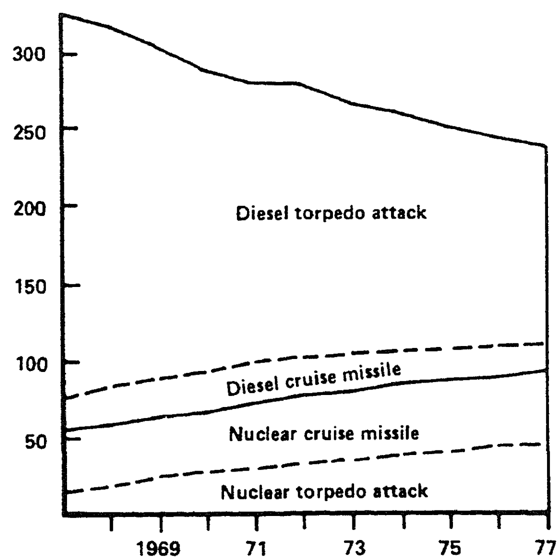

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Figure 11-17.—Soviet attack-cruise missile submarines.

ircraft. These units may operate independently s part of a screen or as part of a special group n support of another force.

Each type of craft has advantages and lisadvantages as ASW units. Ships have the eakeeping capability of conducting sustained perations in all but the most severe weather and ave the ordnance capability of carrying out nultiple attacks. A drawback is their relatively low speed, which limits their areas of search nd lengthens their transit time to a contact area.

Fixed-wing aircraft are capable of searching arge areas in a relatively short time and, epending on type, have a substantial attack apability. Their main limitations are endurance ime and their need to return to base for refueling.

Helicopters have a distinct advantage in their nobility, capacity to hover, and ability to launch eapons on a precise point. Disadvantages lie in eir limited weapons capacity and endurance me.

HIPS

All destroyer type of ships (DD, DDG, FF, FG) and cruisers (CG, CGN) are capable of onducting antisubmarine operations although the rincipal role of cruisers is antiair warfare. dditionally, aircraft carriers have ASW aircraft nbarked.

ensors

Sonar is the principal means by which ships etect submarines, but radar, electronic warfare support measures (ESM), and visual searches are not neglected. Many conventionally powered submarines still must surface or expose a snorkel to recharge batteries.

The most widely installed sonar system is the AN/SQS-26, which provides long-range coverage in five basic modes of operation: (1) omnidirectional transmission; (2) rotating directional transmission; (3) convergence zone; (4) bottom bounce; and (5) passive listening. Depending on water conditions and mode of operation, detection ranges of several miles may be achieved.

As has been stated, submarines operating beneath a layer may escape detection because the sound pulse does not penetrate the layer. A variable depth sonar (VDS) system was developed to overcome this disadvantage. The VDS can be lowered to the depth best suited to sound transmission, and it often can be lowered past a layer. Older VDS sets consist of a towed transducer that operates in conjunction with a shipboard hull-mounted sonar. Newer sets operate independently of shipboard sonars and are called independent variable depth sonar (IVDS).

Weapons

The principal shipboard antisubmarine weapon is the Mk 44 or Mk 46 homing torpedo. The Mk 44 is being phased out, but it will continue to see service for some time. Both torpedoes may be launched from the triple-tube launcher and as an ASROC component.

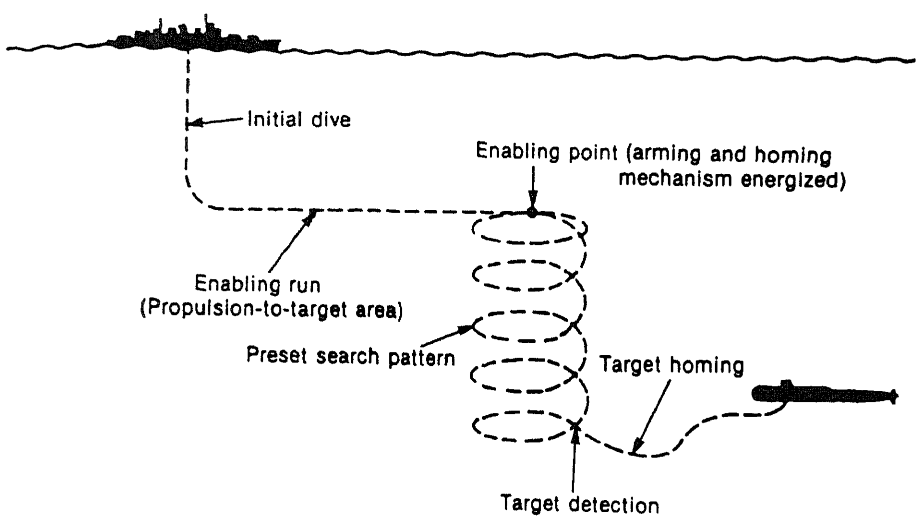

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Figure 11-18.—A characteristic run of a homing torpedo.

When the torpedo is surface launched, it is gyro controlled to a point in the vicinity of the target. This initial run is termed an enabling run, at the end of which (the enabling point) the torpedo exploder is armed, an influence device is set to function, and the homing mechanism is activated to search for the target. The search pattern may be helical, zigzag, or circular, and usually includes a fixed depth zone (search floor and search ceiling) in which the torpedo searches down to the floor, back to the surface, down to the floor, and so on. When the homing mechanism detects a target, the torpedo attacks. When the target is within the effective range of the torpedo's explosive charge, the influence mechanism activates the exploder to set off the main charge (fig. 11-18).

An active homing torpedo transmits sound pulses and homes on echoes returned from a target. A passive homing torpedo homes on noises generated by the target. The Mk 44 and Mk 46 torpedoes have both active and passive homing capabilities. The Mk 44 is electrically driven, while the Mk 46 uses a special liquid propellant.

The antisubmarine rocket (ASROC) is a subsonic solid-fuel, rocket-propelled antisubmarine ballistic projectile. The missile has two configurations—an acoustic homing torpedo or a nuclear depth charge.

Sonar transmits pertinent submarine data to the fire control system which, in turn, computes anticipated target position, rocket motor thrust cutoff velocity, and water entry point of the payload. At the predetermined velocity, the rocket motor separates from the missile, which continues on a ballistic trajectory. After several seconds of flight, the airframe is separated from the payload. If a torpedo is fired, a parachute opens to slow the rate of descent to a safe water entry speed. If a depth charge is fired, it free falls into the water. (See fig. 11-19.)

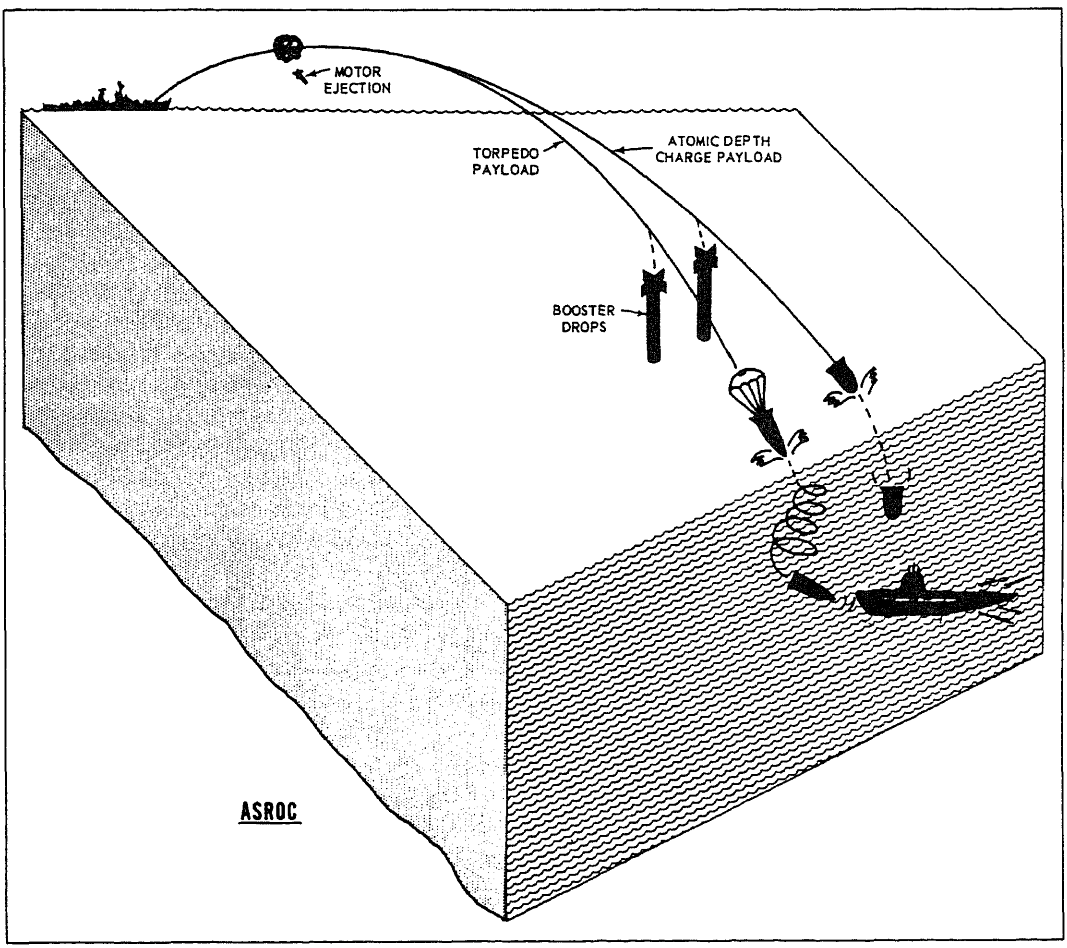

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Figure 11-19.—ASROC.

The ASROC launcher, shown in figure 11-20, can also fire the Harpoon antiship missile. Guided missile cruisers having the appropriate integrated system can fire ASROC from their missile launchers.

AIRCRAFT

Special advantages of aircraft in ASW are their extended radius of action, high mobility, and ability to select the altitude that will provide the best search coverage. Further, a submarine generally is of no menace to aircraft.

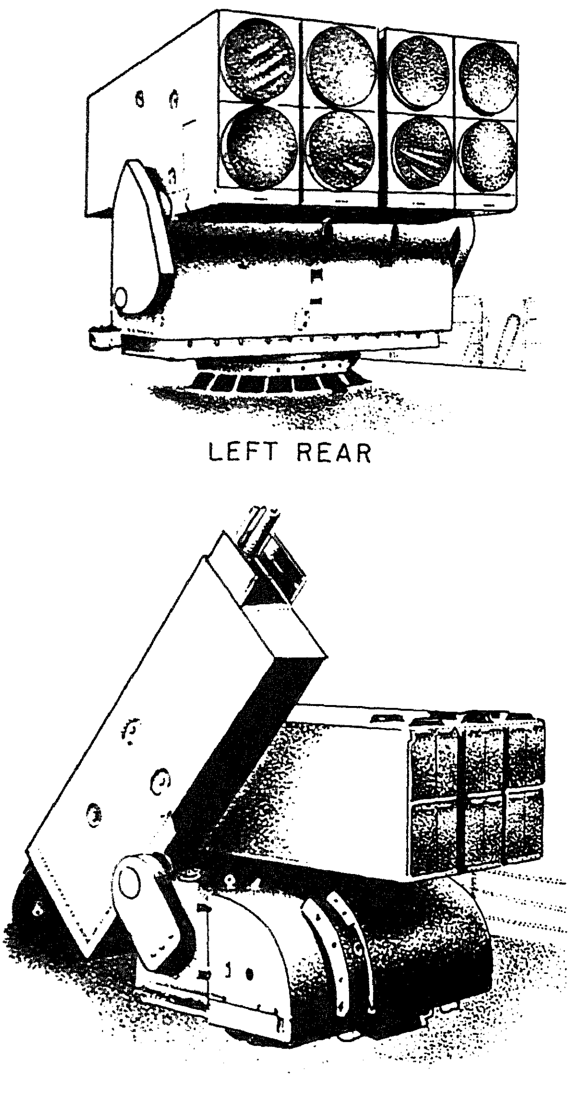

Figure 11-20.—The ASROC cellular launcher.

Fixed-wing aircraft fall into two categories: land based and carrier based. Land-based aircraft consisting of the P-3B or P-3C Orion are assigned to patrol (VP) squadrons. Carrier-based aircraft, S-3A Viking, are assigned to air antisubmarine (VS) squadrons.

Carrier-based helicopter ASW squadrons are designated HS and consist of the SH-3D and SH-3H Sea King. ASW helicopters assigned to destroyers and similar type combatants, the SH-2F Seasprite, are units of helicopter antisubmarine light (HSL) squadrons.

Sensors

Aircraft ASW sensors may be divided into two categories: acoustic and nonacoustic. Acoustic sensors are sonobuoys and sonar. Nonacoustic sensors include radar, ESM, MAD (magnetic anomaly detection), and FLIR (forward looking infrared). Radar and ESM equipments operate in essentially the same manner as their shipboard counterparts.

SONOBUOYS.—Sonobuoys are expendable underwater detecting devices that operate in either a passive or active mode and are either directional or nondirectional in indicating target position. They detect underwater sounds and relay information via radio transmissions to the aircraft. Airborne components in the sonobuoy system include receivers, analysis, and display equipment.

The S-3A carries 60 sonobuoys and has an acoustic data processor (ADP). The ADP is a multichannel, digital, acoustic frequency analyzer that processes both active and passive sonobuoy data and which, in conjunction with a general-purpose digital computer, classifies signals and determines their threat nature. Through a computer data link, the S-3A can communicate with other data systems.

The SH-2F carries 15 sonobuoys, a sonobuoy receiver, and an active buoy processor. Buoy data is relayed via data link to the ship for display and analysis. The SH-3H also carries sonobuoys in addition to its dipping sonar.

NOTE: Helicopters are considered as ships not under command when they are hovering with their sonar in the water. They should not be approached within 500 yards and should be passed on the downwind side.

Sonobuoys are laid in various patterns to detect, localize, and track submarines. They

initially operate in the passive mode to avoid detection by the submarine. When the aircraft is ready to attack, selected buoys can be commanded via radio to become active, thereby supplying range and bearing information to the aircraft.

SONAR.—Although the dipping sonar used by the SH-3H is not as sophisticated or as powerful as shipboard sonars, it has the advantage of being free of the noise interference generated internally aboard ship (movement through the water, main propulsion machinery, auxiliary machinery, and so on). With a cable length of over 400 feet, the sonar ball can often be lowered below a layer. The maximum range scale of a typical set is 20,000 yards. Both passive and active modes are used.

MAD.—Magnetic anomaly detection equipment is carried by all ASW aircraft. In fixed-wing aircraft, the MAD sensor is affixed to a boom that extends from the tail. Helicopter MAD gear is towed on a cable. Although attacks can be made based on MAD information, the unit is not generally suitable for search operations. The usual procedure is to localize a contact with sonobuoys, then make MAD verification runs over the area. Upon contact the sensor operator transmits MADMAN. Tracking and/or attack procedures are then initiated. MAD equipment is very sensitive, but a submarine's anomaly (distortion of the Earth's magnetic field) is quite small, depending on the submarine's size, alignment in the magnetic field, degree of its permane magnetization, and the latitude at which it detected. The aircraft, therefore, must fly very l to ensure success in detecting the submarine (fi 11-21).

FLIR.—Forward looking infrared acts as supplement to the aircraft's high resolution rad FLIR detects thermal radiation and prese contacts on a TV-like CRT display. FLIR c penetrate smoke, haze, camouflage, and light fo and it can be used for such tasks as navigatio terrain avoidance, target tracking, and g laying.

Weapons

The type and amount of ordnance carried aircraft depend on several factors, such as the ty of aircraft, mission, and fuel load. The SH-3 can carry one Mk 46 torpedo, while the 2H-2F c carry two. The ordnance load of the S-3A is fo torpedoes or a combination of torpedoes, min and special weapons carried in two bays. Rocke flares, and bombs can be carried on wing pylo The P-3C can carry a much larger load, of cour than can the S-3A. It also employs the HA POON missile.

Light Airborne Multipurpose System

Sonar has been developed to the point th depending on water conditions, contacts can

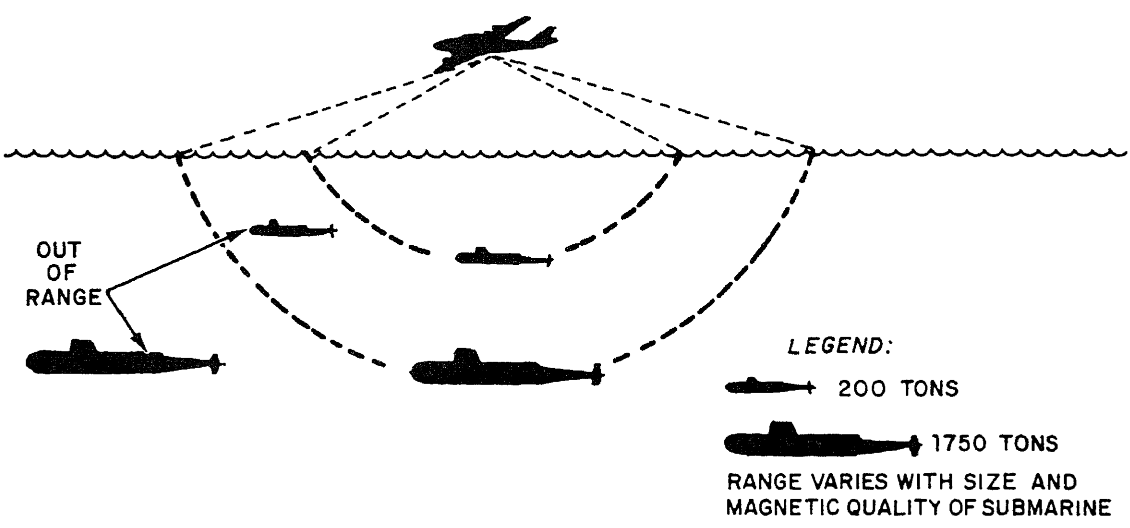

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Figure 11-22.—SH-2F.

detected 50 or more miles from the ship. Such ranges are not only beyond the ship's normal weapon capability, they also cause problems in contact classification. With the advent of the light airborne multipurpose system (LAMPS), however, the destroyer-helicopter team has overcome these difficulties. In addition to their ASW role, LAMPS helicopters play a part in the antiship missile defense system.

Sensors carried by the SH-2F include a high resolution search radar, ESM receivers, passive and active sonobuoys, and MAD (fig. 11-22). When the shipboard sonar detects a contact at great range, the LAMPS is vectored to the contact area and commences its search by dropping several sonobuoys.

As with the S-3A, the sonobuoy pattern laid by the SH-2F is the key to successful ASW operations. MAD is used for contact confirmation and classification and is accurate enough for conducting attacks. Active and passive sonobuoy data are relayed via data link to the ship where special equipment in CIC processes and interprets the information. Contact prosecution instructions are then sent to the helo via the data link. In the event of a failure in the shipboard system, the helo has the capability of decoding active sonobuoy signals and initiating an attack with its Mk 46 torpedoes.

The number of ships with LAMPS capability is approaching 100. (Each ship must be certified as to its ability to operate helicopters.) A typical LAMPS detachment, such as that aboard a frigate, consists of three pilots, two aircrewmen, and eight maintenance personnel. Spruance-class destroyers can carry two Seasprites, so their aviation personnel assignments are larger.

The other major role of LAMPS is in antiship surveillance and targeting (ASST), whereby the helicopter extends the parent ship's radar and ESM detection range. The ASST function is particularly important with regard to detection of ship-to-ship missile platforms and/or signals emitted for the missile's guidance.

Secondary capabilities of LAMPS, after appropriate modifications of the aircraft (such as removing an auxiliary fuel tank), include search and rescue operations, medical evacuation, personnel transfer, and vertical replenishment.

The current LAMPS system is designated Mk I. Scheduled for introduction in the early 1980s is LAMPS Mk III, which will have improved sensor, display, navigation, and communication equipment and a greater operational radius.

ANTISUBMARINE OPERATIONS

Antisubmarine warfare may be conducted by ships or aircraft operating independently or as a team conducting coordinated attacks. ASW units may be formed as a screen to protect a main body

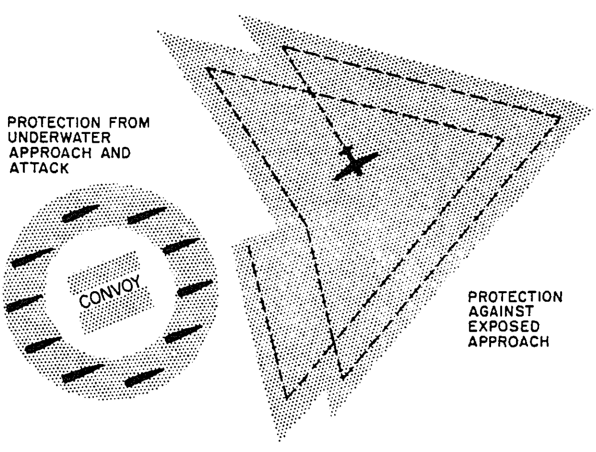
(fig. 11-23), or they may be separately organized as an ASW group to provide distant support for another force.

When contact is gained or a report of a possible submarine is received, ships may be detached from the screen or the support group to form a search attack unit (SAU). The SAU proceeds to the contact area and commences searching for the submarine. Aircraft, as available, assist in detecting, localizing, tracking, and attacking the submarine.

SEARCHES

An ASW search is a systematic investigation of an area to determine the presence of a submarine. Search operations are carried out by ships, fixed-wing aircraft, and helicopters. Basic types of searches are area, intercept, and lost contact. Basic search patterns are rectangular, sector, and expanding square, depending on the purpose of the search and the area to be covered. A rectangular search is a series of sweeps across a specific area. Sector searches are usually long range in nature to provide the earliest possible warning (fig. 11-23). An expanding square search is an expanding rectangular pattern starting at the last known position of the contact.

An area search is used when the location of the reported submarine is not definitely known. The size of the area and, therefore, the number of units required depends on the time elapsed since the probability area was established and on the accuracy of the report. Fixed-wing aircraft are the most effective in this type of search.



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A lost contact search is started immediately after contact is lost. This search is normally of short duration, being terminated after about 15 minutes by ships or helicopters, and after 30 minutes by fixed-wing aircraft.

A close search is a small area search used after a lost contact search fails to locate the submarine or when it is believed that a lost contact search will not contain the submarine. Both fixed-wing and rotary-wing aircraft may be used. The value of the helicopters, however, depends on their time of arrival at the contact area.

An intercept search is a form of close search used when a submarine is in position to threaten the main body. Because the area in which interception may be made is a moving and expanding one, units must arrive in the area as soon as possible.

CONTACT CLASSIFICATIONS

Classification is the decision as to whether a contact is or is not a submarine. It is the method by which commanders inform their superiors and other units of their opinions concerning contacts being investigated. There are four classifications.

1. CERTSUB. A contact that has been sighted and positively identified as a submarine is classified CERTSUB (certain submarine).

2. PROBSUB. A contact that displays strong cumulative evidence of being a submarine is classified PROBSUB (probable submarine). This classification is based on the evaluation of data from one or more sensors (radar, sonar, MAD, sonobuoys, and so on).

3. POSSUB. The classification POSSUB (possible submarine) is applied to a contact on which available information indicates the likely presence of a submarine, but on which there is insufficient evidence to justify a higher classification. The classification POSSUB must always be accompanied by an assessment of the confidence level as follows:

a. Low confidence: A contact that cannot be regarded as a nonsubmarine and which requires further investigation.

b. High confidence: A contact which, from the evidence available, is firmly believed to be a submarine but does not meet the criteria for PROBSUB.

4. NONSUB. The evaluator is entirely

ANTISUBMARINE ACTION

An antisubmarine action is an operation by one or more ASW ships or aircraft, or a combination of the two, against a particular enemy submarine. Any number of attacks may be made. The action ends with destruction of the submarine or if contact is lost and cannot be regained.

There are two types of attack—urgent and deliberate. An urgent attack, made when a submarine poses an immediate threat to a protected body, is a harassing attack delivered with maximum speed but with minimum accuracy. It is a defensive move designed to keep the submarine off balance by firing diversionary weapons.

A deliberate attack is designed to destroy the submarine. It is delivered with maximum accuracy using the best information and weapons available. Deliberate attacks should be undertaken as soon as possible after an urgent attack.

SEARCH ATTACK UNIT

A search attack unit (SAU) is one or more ships separately organized or detached from a formation as a tactical unit to search for and destroy submarines. An SAU may be augmented by fixed-wing aircraft (usually the S-3A) and helicopters, preferably those with dipping sonar.

Figure 11-24 illustrates a typical situation. A search aircraft detects a submarine and tracks it by means of sonobuoy patterns. A search attack unit is vectored to the contact area where it commences its search and makes attacks assisted by aircraft.

The SAU commander decides the best method of approach to datum and promulgates search and attack plans.

All units must be alert for torpedoes fired by the submarine. Figure 11-25 illustrates recommended maneuvers when a torpedo is detected.

SUBMARINE COUNTERMEASURES

Submarines can and do take specific countermeasures against surface ship and aircraft detection and attack. Some of these countermeasures are similar to those taken by

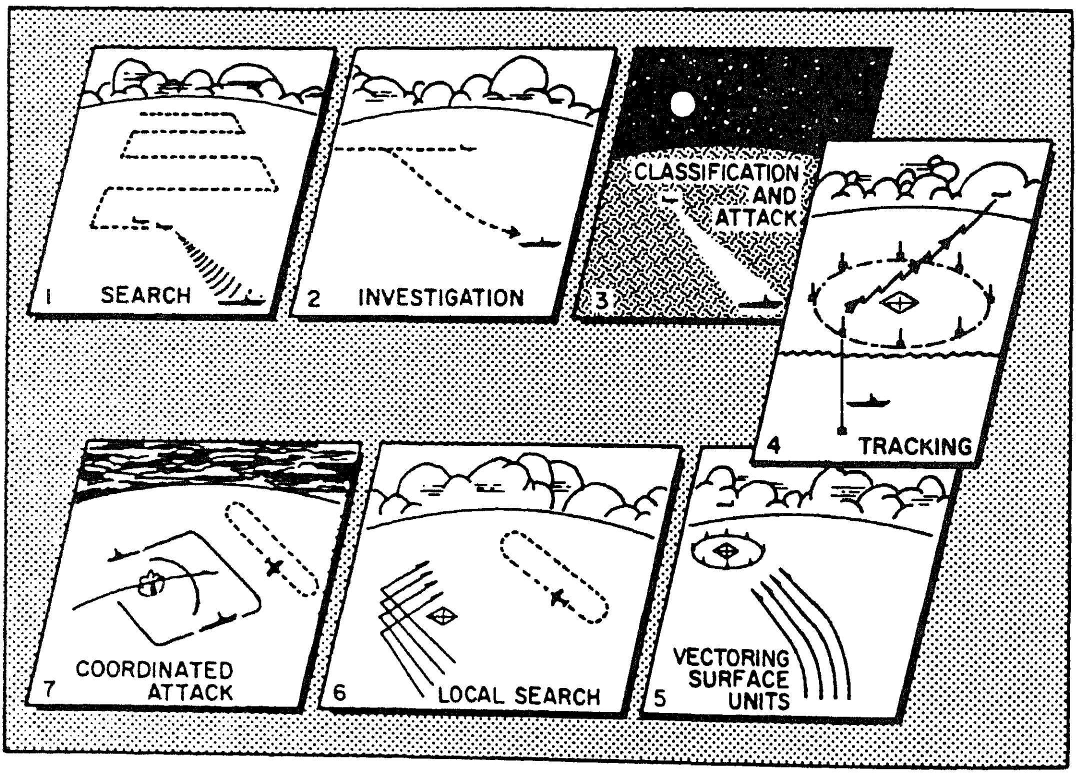

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Figure 11-24.—Coordinated operations.

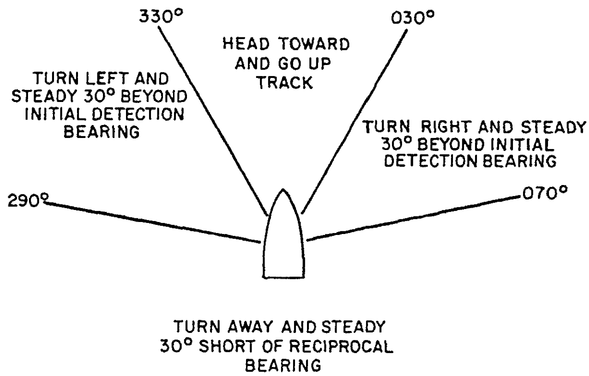

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Figure 11-25.—Straight running torpedo evasion guide.

surface ships; others are designed to make the submarine harder to detect on sonar or hydrophones. Still others are intended to deceive or confuse the attackers. In either case, the result (if successful) is to make the attacker lose contact with the target.

In practice, the effectiveness of the countermeasures in deceiving the attacker, and the ability of the attacker to penetrate the deceptions and maintain contact, depend principally on the tactical ingenuity of each side. Earlier in this chapter you noted the principal advantages and disadvantages of the submarine as compared with the surface attacker. In ASW, each combatant makes the most of the advantages (including psychological ones) and tries to overcome the other's stratagems. The variations and combinations possible are endless. ASW has been called a *cat-and-mouse* game. This is not entirely accurate, since the *mouse* is as dangerously armed as the opponent, but in two respects the comparison is apt—one successful blow is likely to decide the issue, and, in contrast to open combat between air and surface opponents, patience and watchfulness over a prolonged period are likely to be the decisive factors.

The list below includes the principal types of countermeasures that submarines can now use.

SUBMERGING. This is the primary natural defense of the submarine against detection. There are several degrees of submerging, from running with deck awash, to snorkel depth (running with the snorkel, periscopes, and antennas just above the water surface, but with the entire superstructure submerged), to periscope depth (with only the attack periscope protruding from the surface), to shallow submergence (about 60 to 100 feet), to deep submergence (at a maximum or *test depth* for the submarine). A snorkeling conventional submarine can continue to run on diesels and charge its battery. Although it presents a reduced target to visual and radar search, its propulsion machinery is at its noisiest. At any speed exceeding a couple of knots, the protruding parts develop a wake that grows proportionally more noticeable with speed, particularly if the water is smooth. And in very cold weather, the diesel exhaust through the snorkel forms a plume of white vapor. When the submarine is slightly deeper, at periscope depth, the periscope by itself is much harder to spot than the snorkel and associated gear, but it and its wake are still detectable, even if marginally, to radar and eye. At shallow depths (down to 100 feet or so), a speeding submarine does cause noticeable turbulence on the surface if the sea is relatively calm, and its hull can sometimes be spotted visually by aircraft. When the submarine is deeply submerged, its presence is rarely betrayed by any evidence on the surface. Where the sea bottom is not deep, a submarine can rest on the bottom next to a wreck, reef, or turbulent area to present virtually no target to echo-ranging sonar.

SILENT RUNNING. Submarines must reduce noise radiation as much as possible to avoid detection by hydrophone. Chief sources of noise are echo-ranging sonar, operation of propulsion machinery (particularly diesel engines), operation of other machinery (such as ventilating gear and pumps), cavitation produced by rotation of screws above certain critical speeds, and screw noises from other causes (such as deformed blades). A submarine commander can order any of several degrees of silent running, ranging from reduction of running speed and shutdown of echo-ranging sonar to complete stoppage of all machinery and even prohibition of the crew's talking above a whisper. Silent running conditions are ordered, of course, only when the submarine is submerged. A submarine snorkling or running on the surface under diesel power is at least as noisy as any similarly powered surface vessel. Electric drive at the same speed is much less noisy. Nuclear submarines, as previously mentioned, are as noisy or noisier than conventional submarines; however, they are capable of running at much greater depths.

A submarine running silent can still attack by releasing a *swim-out* homing torpedo against a surface attacker. Conventional torpedoes are now forced out of the tube by a hydraulic ram. This action still creates noise but eliminates the large

air bubble that was forced out of the torpedo tube when air was used. A *swim-out* homing torpedo propels itself out of the tube, runs upward to a set depth and begins to search for its target (while the submarine dives) and homes on the surface ship's screw noises.

USE OF THERMOCLINES. A previous section has explained how the path of sound waves in seawater is distorted by differences in water density. Submarines are fitted with recording bathythermograph units that function whenever the ship dives, so that the presence of thermoclines (interface between warmer and colder water layers) is continuously indicated. The submarine can dive under a thermocline and, in most cases, cause the attacking vessel to lose contact entirely. The new VDS sets, discussed earlier, make it more difficult for the submarine to use a thermocline as a countermeasure.

HIDING BENEATH SURFACE VESSELS. Because a sonar is relatively *deaf* in the area directly below it, a submarine can find concealment directly below its attacker. Or a submarine can hide directly below some other ship, using the surface vessel's screw noises and turbulent wake to mask its own sonar echo. In this position the submarine can use swim-out homing torpedoes, as described earlier.

FALSE TARGETS. A mass of air bubbles is detected by sonar as a target. Submarines can release a false target can (FTC) out of their signal ejector. The can creates air bubbles that appear as a target for the benefit of surface sonar. The target doesn't last long, and it betrays its nature to a sharp sonarman because it has no Doppler, but it can distract the attacker long enough to cause loss of contact. A German-originated device specifically designed to eject bubbles for this purpose was called the *Pillenwerfer*, which is sometimes used to refer to similar devices on our own submarines.

Another type of false target is the beacon. It is also fired from the signal ejector and emits a continuous noise for a set time duration. The beacon can simulate a submarine screw, sonar ping, or other sounds. After ejecting the device, the submarine usually heads downward and in the opposite direction. A beacon not only distracts passive sonar search but also can attract ASW homing torpedoes intended for the submarine.

SUBMARINE AND ANTISUBMARINE WARFARE IN THE FUTURE

No one can say just what warfare will be like in the future, but the outlines that can be conjectured are clear enough to show that naval forces under the sea surface will have much to do with determining who has command of the sea. Based on past experience and on new developments, submarines will likely be used in any or all of the following ways by both sides:

1. To destroy the enemy's navy and merchant marine
2. To impede or cut off the flow of supplies and troops by threat of attack on merchant shipping
3. To deny use of shipping lanes and harbor areas to the enemy's merchant shipping and naval units by submarine-planted mines
4. To divert in greater or lesser degree from the primary mission of winning the conflict by causing the enemy to concentrate on antisubmarine warfare.
5. To mount direct attacks by submarine-launched guided missiles and rockets
6. To function as pickets
7. To function as transports in situations where the submarine's special characteristics are important
8. To function as antisubmarine units

No individual piece of equipment or type of weapon can solve the ASW problem. Now, and in the future, the task group commander must use various ASW units, either singly or in a combination, to attain their greatest advantage.

Tactics will change with new developments of detecting equipment and weapons. Today, however, and in the near future, it still will require the combined efforts of all types of ASW units to meet the submarine threat.

CHAPTER 12

AMPHIBIOUS WARFARE

An amphibious operation is an attack launched from the sea by naval and landing forces embarked in ships or crafts against a hostile shore. The inherent naval character of the amphibious attack is reflected in the principles that govern the organization of the forces participating and the conduct of the operation. The ability to conduct such operations effectively is a measure of a nation's competence in applying the elements of seapower and airpower in a coordinated effort.

The usefulness of the amphibious operation stems from mobility and flexibility; that is, the ability to concentrate balanced forces and to strike with great strength at selected points in the hostile defense system. An amphibious operation exploits the element of surprise and capitalizes upon enemy weaknesses through application of the required type and degree of force at the most advantageous locations at the most opportune times. The mere threat imposed by the existence of powerful amphibious forces may induce the enemy to disperse his forces; and this, in turn, may result in his making expensive and wasteful efforts in attempting to defend his coastline.

Amphibious assaults must be conducted in the face of certain additional and distinguishing difficulties. Natural forces—unfavorable weather, seas, surf, and other features of the hydrography—represent hazards not normally encountered in land warfare. Logistics problems include loading thousands of troops and large quantities of material into ships, moving them to the objective area, and then landing them in exactly the proper sequence on open beaches or landing zones that may be under enemy fire. All such problems require extraordinary attention to detailed planning.

The closest cooperation and most detailed coordination among all participating forces in an amphibious operation are essential to success. The forces must be trained together, and there must be clear understanding of mutual obligations and of the special capabilities and problems of each component.

Amphibious striking forces normally include Navy-Marine Corps forces, but they may include personnel from every service of the armed forces and civilian-manned merchant ships. These forces are integrated into a task organization to form a single cohesive amphibious striking force capable of executing its mission with utmost efficiency. The keynote of successful amphibious operations is the complete coordination and unity of effort among all the participating elements of land, sea, and air forces.

Amphibious operations are conducted to establish a landing force on a hostile shore to (1) prosecute further combat operations, (2) obtain a site for an advanced naval or air base, and (3) deny the use of an area or facilities to the enemy.

Examples of operations conducted to prosecute further combat operations are those at Normandy and Salerno, which paved the way for the employment of large land armies on the mainland of France and Italy, respectively.

Seizure of land for advanced-base purposes is best illustrated by the island-hopping campaigns in the Pacific where, as the United States brought the war closer to Japan's doorstep, advanced bases were established on some of the captured islands. Advanced bases are primarily fleet anchorages from which task forces of ships can be supported. The use of advanced bases shortens the lines of supply and communications and thereby decreases their vulnerability.

Denial of an area to an enemy is illustrated by the Aleutian campaign in the Pacific. The enemy was driven off the islands of Kiska and Attu, and then these islands were occupied by our forces to prevent their use by the enemy. For the remainder of the war, reconnaissance and raiding operations were conducted from the Aleutians by U.S. ships and aircraft.

There are four types of amphibious operations. The assault is the principal type. It is distinguished from the other types in that it involves establishing a force on a hostile shore.

A withdrawal is when forces are withdrawn from a hostile shore to sea. The evacuation of British and allied forces from Dunkirk during the early stages of WW II was a withdrawal. A demonstration is a deceptive show of force operation intended to cause the enemy to commit his forces in an unfavorable action. Lastly, a raid is a landing conducted on a hostile shore to inflict damage, gain information, create a diversion, or evacuate individuals and/or materials. The raid is always followed by a planned withdrawal.

HISTORICAL BACKGROUND

World War II produced the greatest series of landing operations in history. Their magnitude, both in number and size, and the diversity of the landings in the Pacific, in Europe, in the Mediterranean, and in North Africa tend to create the impression that the amphibious operation is a new type of military enterprise. Military history contains many instances of landing operations conducted in all parts of the world. One of the first recorded landing operations dates back nearly 3000 years. This was the half-legendary attack of the Greeks upon the city of Troy in Asia Minor near the Dardanelles. Homer's *Iliad* relates that the Greeks crossed the Aegean Sea, stormed the beaches near Troy, and after 10 years of war, destroyed that city.

LANDINGS IN WORLD WAR I

World War I gave us our first classic example of modern large-scale landings. The combined operation conducted by the British during the Dardanelles campaign in 1915 constituted a major effort. In the assault landings on the Gallipoli Peninsula, troops landed with few or no losses on beaches that were unopposed or lightly defended. However, extremely heavy losses were suffered at the strongly defended beaches even though the troops were successfully put ashore. Land operations for the seizure of the Gallipoli Peninsula were unsuccessful. In fact, a secure beachhead never was established. Although cooperation between troop and naval components was excellent, the logistic buildup on the beaches never was adequate, and communications were primitive. The landing forces were finally evacuated in January 1916 after a campaign lasting 8 months, and the impracticability of attempting landings against opposition apparently was conclusively demonstrated.

DEVELOPMENT BETWEEN WORLD WARS

During the 25 years between Gallipoli and Guadalcanal, the United States developed the doctrine, organization, tactics, and techniques necessary for success in amphibious warfare. The Marine Corps was responsible for advancing this type of warfare during that period. In 1921 the Commandant of the Marine Corps, Major General John A. LeJeune, USMC, directed the Marine Corps Schools to launch a full-scale attack on the problems of amphibious warfare. In addition to actually conducting landing operations, the Marine Corps and the Navy established a workable doctrine for both troop and naval components of an amphibious attack force. Organizations, weapons, and equipment were tested in actual use, and recommendations were made for further development. The doctrine was also supplemented with new techniques evolved in training and directed mainly at improving coordination of participating air, ground, and surface elements.

AMPHIBIOUS OPERATIONS IN WORLD WAR II

Every major offensive campaign the United States launched during World War II was initiated by an amphibious assault.

Pacific Theater

The first American amphibious landings of World War II were made in the Guadalcanal campaign begun in August 1942. In these operations, executed by the First Marine Division, Fleet Marine Force (at that time, the only amphibious troops in readiness for combat operations), amphibious techniques and doctrine which had been developed were put to, and successfully passed, the final test—proof under fire. The remainder of World War II in the Pacific consisted mainly of offensive land campaigns started from the sea by amphibious assaults of increasing magnitude. The amphibious capture of Luzon, Iwo Jima, and Okinawa came in 1945. Before the Japanese surrender in September 1945, the United States was preparing for the final assault—an amphibious assault—on the Japanese mainland. The pressure exerted on Japan from

the naval and air bases gained by amphibious assaults was of primary significance to the successful prosecution of the war in the Pacific theater, which was predominantly naval in character.

European Theater

The United States entry into the conflict in the European theater was initiated by amphibious landings in French North Africa in 1942. The purpose of this invasion was to secure African bases from which to carry the war to Sicily, freeing Great Britain's lifeline to the Middle and Far East, and opening the way for the invasion of Italy and southern France. July of 1943 found an armada of over 3,000 ships and craft with 160,000 men landing on the beaches of Sicily, an operation eventually destined to force Italy out of the war.

The landings keynoting the invasion of Western Europe commenced on 6 June 1944 over the beaches of Normandy, France. (See figure 12-1.) The magnitude of a major amphibious operation is clearly illustrated by the Normandy landings. In the first 28 days, some one million men, 183,000 vehicles, and 650,000 tons of supplies were landed across the beaches and in artificial harbors by a force of about 3,000 vessels.

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AMPHIBIOUS WARFARE SHIPS

To successfully accomplish an amphibious ration, it is necessary to land thousands of onnel and thousands of tons of equipment, nunition, and supplies on enemy-held shores. Amphibious ships, by virtue of their spezed characteristics, such as heavy lift booms, ty to beach, or capacity for carrying large and y landing craft, are uniquely capable of orming these tasks.

NK LANDING SHIPS

Tank landing ships (LSTs) were a World War evelopment and were used successfully for sporting troops, tanks, preloaded vehicles, nunition, fuel, and all sorts of supplies. l the commissioning of the Newport class T-1179), LSTs built since the war were of the e general design, but were larger, faster, and certain added features that enabled them to y out their missions more effectively.

Bow doors and bow ramp gave access to a hold called the tank deck. Another ramp n the main deck to the tank deck enabled cles to reach the main deck under their power. Some of the added features in post-war design included a turntable in forward part of the tank to turn vehicles without a great deal of maneuvering and booms and winches mounted on the main deck forward of the deckhouse to facilitate handling cargo.

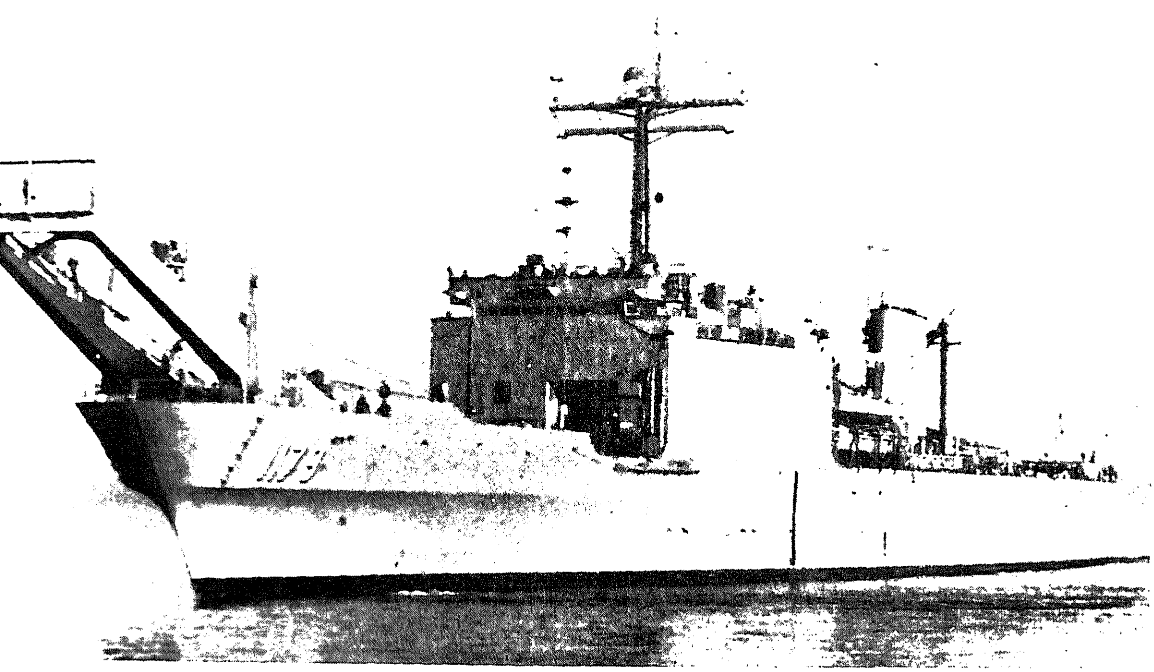
The first LST of a revolutionary new design was commissioned in June of 1969. It was the USS *Newport* (LST-1179). (See figure 12-2). This was the first U.S. Navy combat vessel equipped with a bow thruster (side propulsion unit) to aid in maneuvering.

The *Newport* is the fastest and largest LST ever built. The new design features clipper bow, extended bow ramp vice bow doors, and a rounded bottom. The tank deck is connected to the main deck by a ramp forward of the bridge. Stern doors facilitate loading/unloading of cargo and troops. Vehicle stowage is 500 tons. The stowage area is 19,000 square feet, 5,000 more than previous LSTs.

In addition to transporting and landing amphibious vehicles, tanks, combat vehicles, and equipment in amphibious assaults, these ships can transport and launch a pontoon causeway section in the amphibious objective area.

AMPHIBIOUS CARGO SHIPS

Amphibious cargo ships (LKAs) are used in amphibious assaults to transport and land assault



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equipment, ammunition, and supplies, but only a limited number of troops. Offloading is accomplished by ship's personnel using installed cargo-handling equipment that includes jumbo cargo booms (figure 12-3) of up to 70 tons capacity. Cargo and personnel are transported to the beach by ship's landing craft and other landing and amphibious craft included in the amphibious forces. Cargo capacity is over 5,000 tons or about 300 vehicles.

For an amphibious assault, LKAs are combat loaded; that is, loaded in reverse order of probable need. When this is done, items troops will need first are readily available and can be offloaded first.

AMPHIBIOUS ASSAULT SHIPS

One amphibious assault ship (LPH) (figure 12-4) is designed to embark, transport, and land 1,800 troops and their equipment by means of

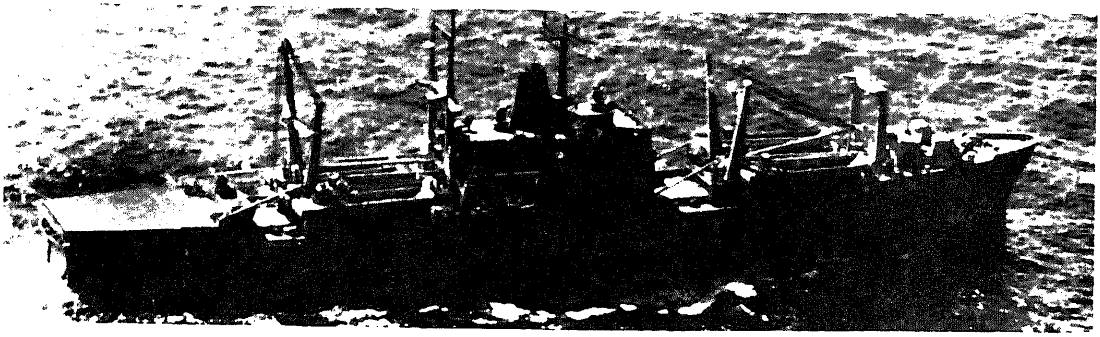

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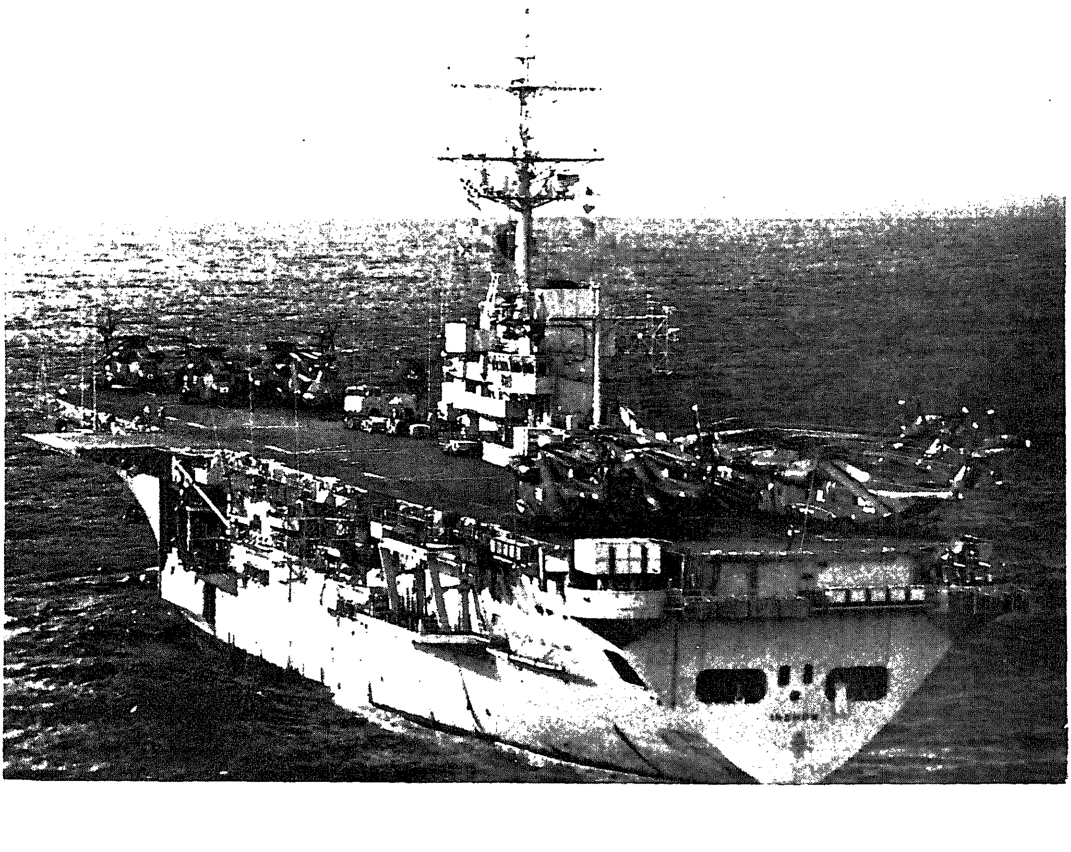
Figure 12-3.—USS El Paso (LKA-117).



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ansport helicopters in conjunction with a each assault. This vertical envelopment is more fective than previous methods of amphibious ndings. The most significant feature is the ability commit the landing force in assault without eing limited to favorable beaches. It provides for tablishment of a beachhead in the enemy's rritory more quickly. The large concentration men and equipment that existed on the landing each in the early stages of the amphibious assault World War II is eliminated. With this dispersal forces, there is less likelihood of extensive sualties.

When not employed in amphibious assaults, PHs have the capability to assist in anti-bmarine warfare.

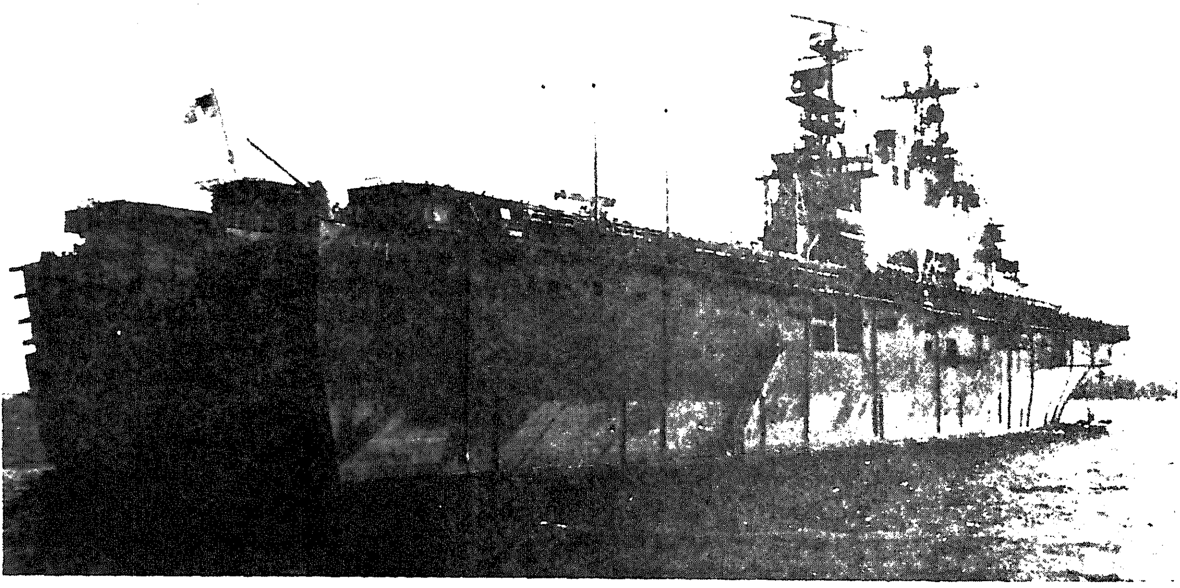
Another amphibious assault ship (LHA) igure 12-5) is able to embark, deploy, and land marine battalion landing team by helicopters, nding craft, amphibious vehicles, and by mbinations of these methods. It combines the atures of the LPH, LPD, LKA, and LSD into single ship. The LHA is also equipped with cilities to provide the commander of an nphibious squadron and the marine landing rce commander flexibility in the exercise of their ntrol and coordination of functions in a nding operation. For self-defense against surface and air attack, the LHA is equipped with 5-inch guns and point defense missiles.

AMPHIBIOUS TRANSPORT DOCK

The amphibious dock transport (LPD) (figure 12-6) incorporates features of the LSD, LPH, and LKA. The LPD can transport their equipment in the same ship and a means of delivery by air and sea is available.

The ships have a telescoping hangar and can operate up to six UH-34 or CH-46 helicopters from the flight deck. They can also serve a satellite landing platform for helicopters from the larger LHA and LPH ships. These helicopters can be used for a variety of missions, troop transport, logistic support, assault support, MEDEVAC, or ASW operations.

Difficulties of offloading over the side are eliminated by transporting the landing craft internally and launching them through an opening in the stern, as in figure 12-7. Craft can be launched while the ship is underway or dead in the water. The deck over the well that carries the landing craft provides a platform for six large helicopters, permitting the landing of troops by air as well as by landing craft.



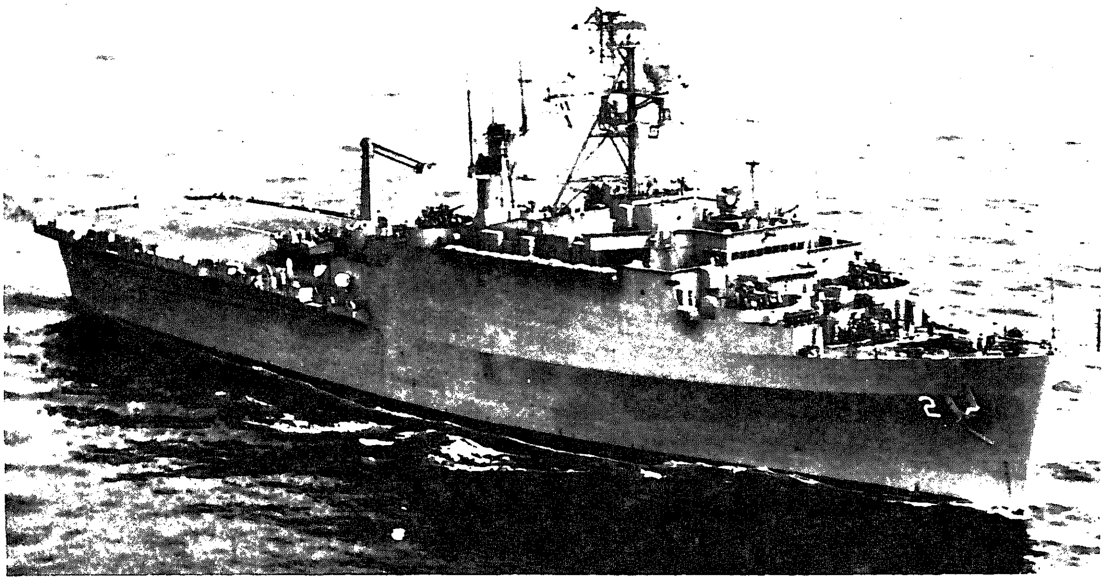


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Figure 12-6.—The dock amphibious transport (LPD) represents a considerable improvement over the LSD design in that it can simultaneously transport troops together with their equipment.

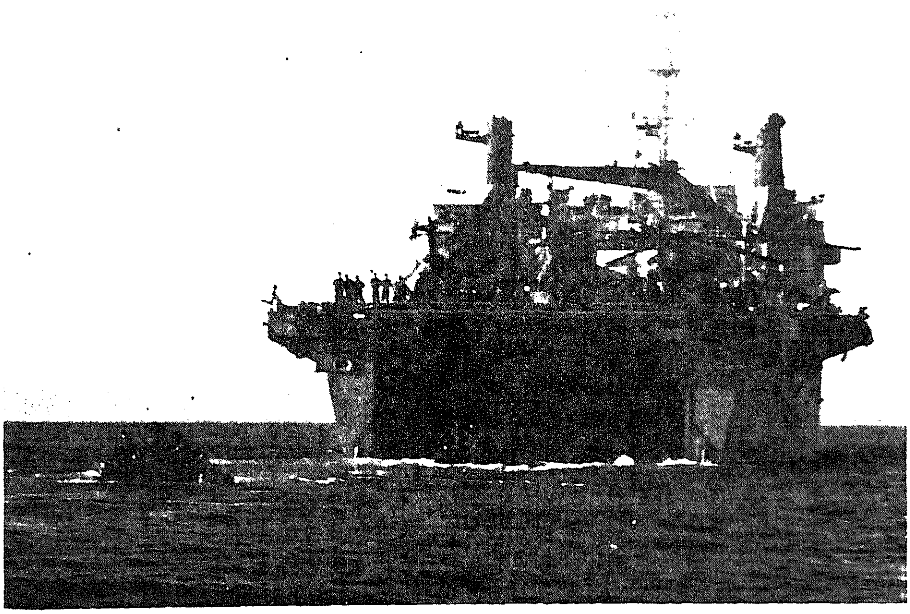

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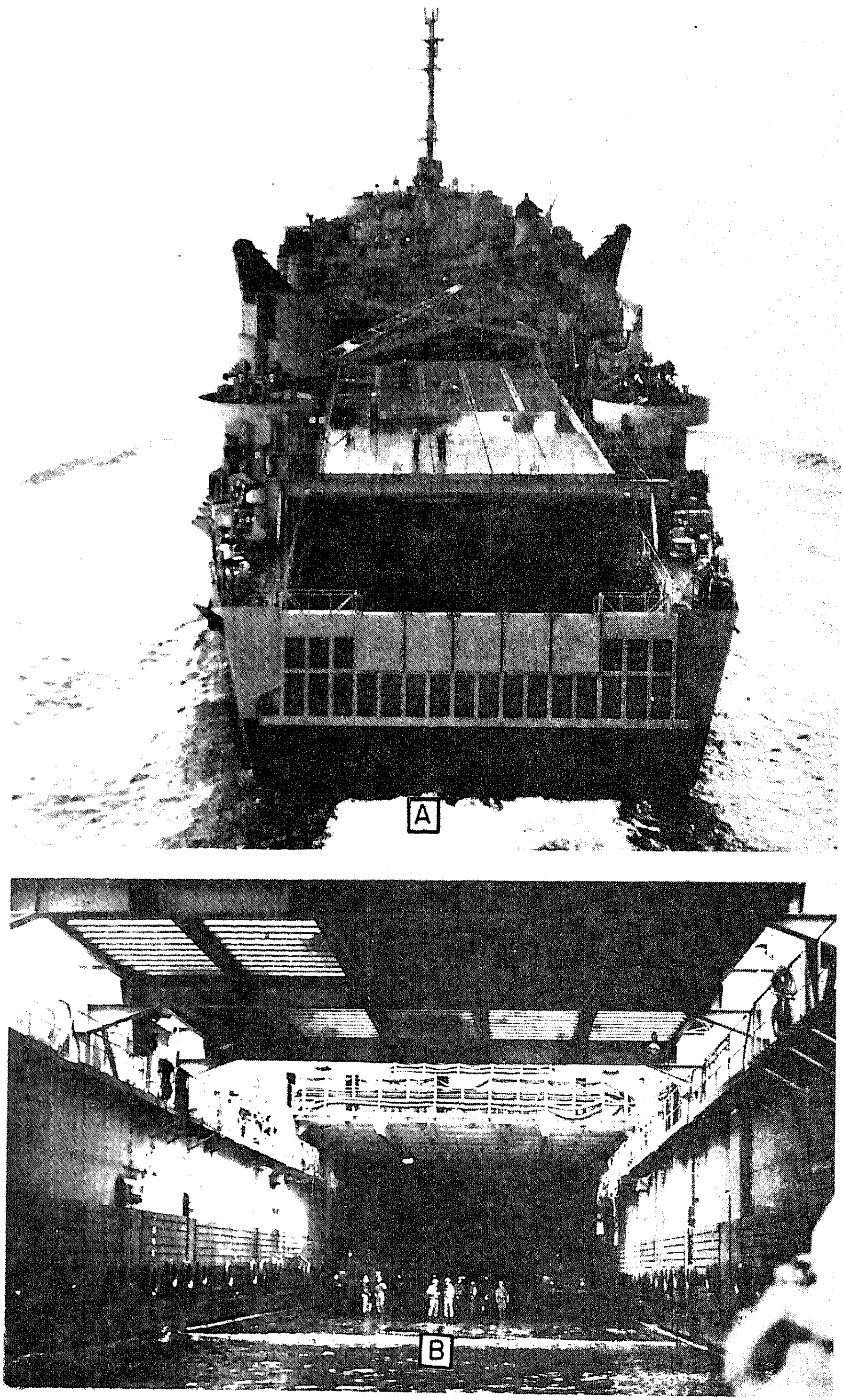
Figure 12-7.—Marine amtracks being launched from the partially submerged well deck of USS Ogden (LPD-5), while the ship steams at 5 knots.



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re 12-8.—USS Alamo (LSD-33). The huge well of this type of ship can accommodate numerous landing craft.

DOCK LANDING SHIP

The dock landing ship (LSD) (figure 12-8A) can transport and launch a variety of loaded amphibious craft and vehicles. It can render limited docking and repair services to small ships and craft and is equipped to refuel helicopters operating from the ship's helicopter landing platform. Between its wing walls, it has a well over 300 feet long and about 50 feet wide, as shown in figure 12-8B. To launch the craft, the LSD is ballasted down, the well is flooded, and the craft move out under their own power. The LSD can transport 18-LCM-6s plus the ship's allowance of four landing craft. It has one helicopter operating spot, which is capable of handling a CH-53 helicopter.

AMPHIBIOUS COMMAND SHIPS

An amphibious command ship (LCC) can serve simultaneously as a command ship for amphibious task force, landing force, and air support commanders during amphibious operations. It provides accommodations and command and communication facilities for the various commanders and their staffs. This ship has the most modern and capable command facilities afloat. At this time, two ships of this type, the USS *Blue Ridge* and the USS *Mount Whitney* (figure 12-9), are in commission.

PHASES OF AN AMPHIBIOUS OPERATION

The planning and prosecution of an amphibious operation are explained below.

PLANNING

An inexperienced observer of an amphibious landing cannot appreciate the extensive planning that goes into one of these operations. Such planning reflects the collected intelligence data on enemy forces and territory concerned and is designed to accomplish the following tasks:

- Embarkation by combat loading methods
- Movement to the amphibious objective area, including defense against air, submarine, and surface attack
- Preassault operations (preparation of the objective area) include gaining and maintaining local air superiority; destruction of enemy forces and installations by naval aircraft, shipboard

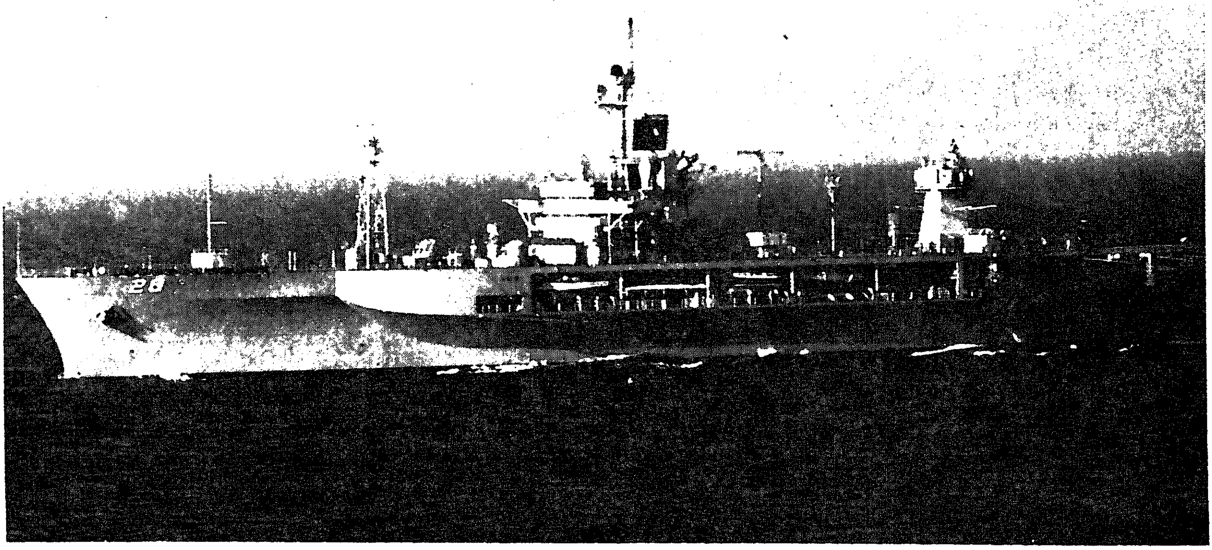

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Figure 12-9.—USS *Mount Whitney* (LCC 20).

guns, and missiles; clearance of mines and underwater obstacles; reconnaissance of beaches by underwater demolition groups; determination of exits inland; and isolation of the objective area

- The ship-to-shore movement, by means of which troops and their weapons, vehicles, and supplies are moved ashore, by helicopters and/or landing craft

- Clearance of beach obstacles and movement inland with tanks, artillery, and light and heavy vehicles

- Naval gunfire, missile, and air bombardment in support of the assault and the movement inland

- Landing of supplies and logistic support buildup

There are other tasks, but these will suffice to illustrate the many requirements that need to be considered and resolved. An amphibious attack can succeed only if it is carefully planned and organized. Timing is extremely important. Planning, the responsibility of the commander and his staff, demands a complete knowledge of the various combat arms employed, and the numerous problems unique to an amphibious operation.

Collection of Information

Current and adequate intelligence is a prerequisite to sound amphibious planning. Therefore, prompt initiation of the collection of essential information is necessary for the valid and timely development of required intelligence.

Collection of the extensive and detailed information needed for planning an amphibious operation is complicated by some or all of the following factors:

1. Distance to the amphibious objective area (AOA) is often great.
2. The amphibious task force is not in contact with the enemy.
3. Many of the available information-collecting agencies are not part of the amphibious task force.
4. The necessity for deception to avoid revealing the time and place of landing may require dispersion of effort by collecting agencies.
5. A relatively long period of time may elapse between the start of planning and the execution of the landings. During this time the characteristics of the objective area and the enemy situation may undergo many changes.

Alternate Plans

Alternate plans, considering the possibilities of loss, delay, or changes in time and place of landing, are necessary. As an additional means of maintaining flexibility, the decision as to which specific plan will be employed may be deferred until a short time before the selected hour of landing.

Planning Procedures

The basic procedures used in planning an amphibious operation are the same as those employed for all types of naval operations. Following receipt from higher authority of the initiating directive, the amphibious task force commander issues a planning directive to ensure that interdependent plans will be coordinated, that planning will be completed in the time allowed, and that important aspects will not be overlooked. The planning directive specifies the principal plans to be prepared, and it sets a deadline for the completion of each major step in the planning process.

EMBARKATION

In a major amphibious operation, troops are assembled at various ports with their equipment and vehicles. In accordance with extremely detailed loading plans formulated during the planning phase, designated ships arrive in these ports at specified times, ready to embark the landing forces.

Each item of equipment is loaded aboard in reverse order of the priority in which it is desired on the hostile beach. Individual loading plans for each ship are prepared by the combat cargo officer of the ship and the commander of the landing force unit to be embarked in that ship. The loading plan is reviewed and approved by the commanding officer of the ship from the viewpoint of his ability to carry it out, and in terms of the safety of his ship.

As soon as the ship is moored, it is in all respects ready for loading. All landing craft have been offloaded, appropriate cargo handling gear is placed in readiness, and all cargo booms are

rigged out as necessary to handle the material to be stowed in each hold. The advance party of troops boards the ship at the embarkation port and proceeds immediately with the details of loading. When all cargo is aboard, the remainder of troops embark and the ship leaves its berth and proceeds to an anchorage to await the forming of the convoy. In crowded ports with few facilities, loading may be accomplished with the ship at anchor. The procedure is similar to that already outlined except that all cargo and equipment must be moved out to the ship by boats, barges, or other lighterage.

REHEARSALS

The schedule for an amphibious operation usually allows for one or more rehearsals. They are carried out under conditions approximating those of the anticipated operation, and rehearsal participants should include all units that will take part in the actual operation. The purposes of rehearsals are to test the familiarity of all echelons with plans, adequacy of plans, timing of detailed operations, combat readiness of participating forces, and effectiveness of communications. If practicable, rehearsals include naval gunfire and air support with live ammunition. Unloading is carried out as determined during planning in sufficient degree to test effectively the tactical and logistic plans, the operation of the ship-to-shore movement control organization, and the functioning of the shore part, including naval components. Each rehearsal is followed by critiques at all levels of command to evaluate the exercise, to emphasize lessons learned, and to correct mistakes.

MOVEMENT TO THE OBJECTIVE AREA

Movement of the amphibious task force to the objective area includes departure of ships from ports of embarkation; the passage at sea; and the approach to, and arrival in, assigned positions in the objective area. Movement may be via rehearsal, staging, and rendezvous areas. The amphibious task force is organized into movement groups, which proceed along prescribed routes in accordance with the movement plan. Usually ships are assigned into fast or slow movement groups, depending on their sustained sea speed. En route to the objective area, the amphibious ships are protected from air, surface, and subsurface attack by forces that may not be a part of the amphibious task force. Carrier striking forces provide air cover and long-range reconnaissance en route to the objective area. In addition, mine warfare ships and other ships suitable for screening, but with other primary functions, may be employed for screening duties during movement to the objective area. The safety of the amphibious ships with their embarked troops, equipment, and supplies is of paramount importance. Landing forces must arrive in the objective area without critical reduction in their combat potential.

PREASSAULT OPERATIONS

Preassault operations are conducted in the objective area by subordinate elements of the amphibious task force, which normally are organized into an advance force. The advance force is a temporary organization and usually is dissolved when the main body of the amphibious task force arrives in the AOA. Some of the tasks accomplished by the advance force are:

1. Destruction of defenses ashore. Beach and landing zone defenses, gun emplacements, observation posts, and other installations that could be used to oppose the landing are destroyed by the advance force. Naval gunfire bombardment and air strikes are used for this purpose.
2. Preparation of sea areas. Minesweeping, defensive minelaying, hydrographic surveying, and net laying are accomplished as necessary.
3. Preparation of beaches and offshore approaches. Underwater demolition teams prepare the beaches and approaches for the passage of landing craft, landing ships, or amphibian vehicles by destroying all obstacles, natural or manmade, including mines, in the offshore area between the 3-fathom line and the high water mark. Obstacles which cannot be destroyed or removed are marked by buoys. Beach reconnaissance information, including detailed data on beach gradients, obstacles, tide and surf, depths of water, routes of exit from the beaches, soil trafficability, defenses and suitability of selected beaches, is transmitted by the advance force to the amphibious task force and landing force commanders.

SUPPORTING OPERATIONS

In addition to the advance force operations normally conducted within the AOA, other supporting operations are carried out prior to and concurrent with the amphibious assault. Examples

of supporting operations are diversionary landings for purposes of deception, interdiction of enemy force movements to isolate the AOA, and remote air operations designed to provide freedom from enemy interference. Supporting operations are conducted by other fleet and theater forces, but they are not considered as part of the amphibious operation. However, since they contribute to the preparation for the amphibious assault, they must be responsive to the requirements of the amphibious striking force.

The most important contribution to the success of an amphibious operation is the attainment and maintenance of local air superiority in the AOA. Great reliance is placed upon air support from the fast carrier striking force to achieve air superiority and to prevent the movement of the enemy in force into, and within, the objective area. There is a continuing requirement for defense against enemy air, surface, and subsurface attack.

THE ASSAULT

The doctrine for a modern amphibious assault calls for completely integrated marine air-ground landing forces that are organized, trained, and equipped to exploit the speed and flexibility of the helicopter. The helicopter is designed to work equally well under all conditions of warfare, large or small, nuclear or conventional. With the development of the troop helicopter and the specialized amphibious shipping in which large numbers of these aircraft may be carried, the amphibious landing is no longer restricted to excellent landing beaches as was the case in World War II and the Korean conflict.

By transporting the assault elements by helicopter, we enjoy greater tactical flexibility. Beach defenses and other strong points can be overflown and bypassed. Key terrain features, widely dispersed, can be seized and occupied rapidly. No longer is it necessary to fight over long stretches of ground to reach these objectives. Also, inland objectives can be approached from any direction. Important tactical objectives, such as airfields, may be quickly taken by helicopter-borne combat teams.

The assault phase begins when the amphibious striking force arrives in the AOA. The tactical unity of the assault forces is maintained insofar as practicable during the ship-to-shore movement. The battalion landing team, consisting of an infantry battalion or similar unit reinforced by such supporting units as may be attached for the assault, is the basic unit of the landing force. Waterborne and helicopter-borne landing teams are organized into "waves" containing the personnel and equipment to be landed simultaneously in a given area.

Ship-to-Shore Movement

Shortly before L-hour and/or H-hour, which is the start of the amphibious assault or the time of the landing of the first wave of helicopters or landing craft, the signal "Land the Landing Force" is executed. Immediately, all amphibious ships offload their boats, which then circle in prearranged areas (as in figure 12-10) until called alongside to receive their cargoes of troops and equipment. (Ships provided with a well deck launch their craft fully loaded.) Helo-teams embark in assigned helicopters. Just prior to L-hour, the helicopters are dispatched to flight rendezvous points where they form with other flights into waves and proceed to their assigned objectives. Fully loaded landing craft are directed to proceed to the line of departure (LOD), forming into waves en route. All of these operations by landing craft and helicopters are closely controlled and synchronized. Normally, the helicopter-borne waves capture their initial objectives prior to the waterborne assault, thereby diverting some defenders from the coastline.

As the waves form at designated points and commence their final approach, shore bombardment measures are intensified. Major emphasis is placed on the destruction and neutralization of hostile defenses most dangerous to the successful landing of troops at the designated beaches or landing zones. Strike aircraft intensify attacks against defensive installations near the beaches, helicopter approach lanes, and landing zones. These attacks are continued until immediately prior to the landing of the leading waves (figure 12-11) at which time the attacks are shifted away from the landing beaches and landing zones to other selected targets to provide continuing support to the assault elements of the landing force. Naval gunfire is continued on the immediate beach and landing zone defenses until the safety of the leading waves requires lifting of fire. Then, close support fire is concentrated on positions farther inland, on the flanks of the landing beaches, or on perimeters of the landing zones.

Overall coordination of air and naval gunfire support is the responsibility of the amphibious task force commander and is preplanned to the

extent possible. Delivery of unsheduled fire support on targets of opportunity and unexpected changes in air operations necessitate continous and close coordination to provide maximum effectiveness with a requisite degree of safety.

The principles and procedures of fire support coordination are not changed by the introduction of nuclear weapons. However, the importance and extent of coordination are increased because of the magnitude of nuclear weapons effects.

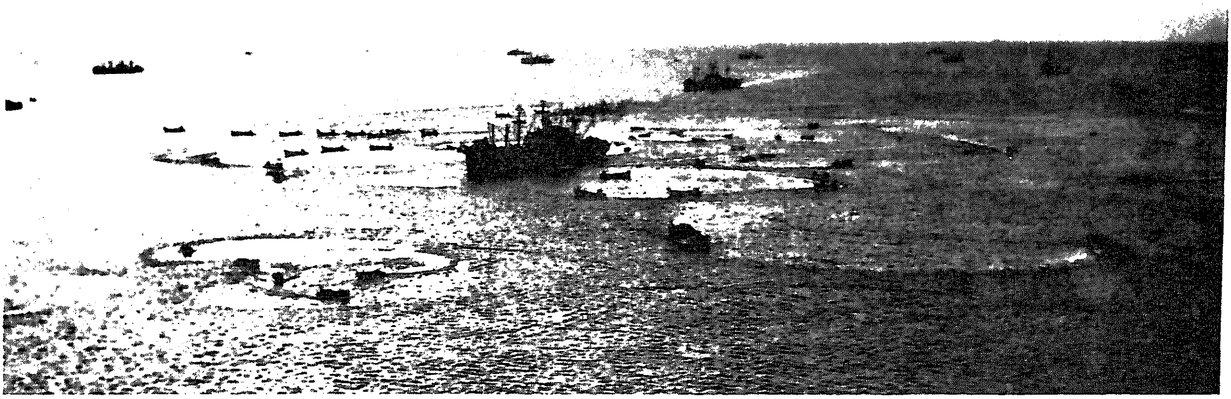

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Figure 12-10.—Circling near the parent ship, landing craft await the signal to go alongside and receive their cargoes proir to beginning the assault.

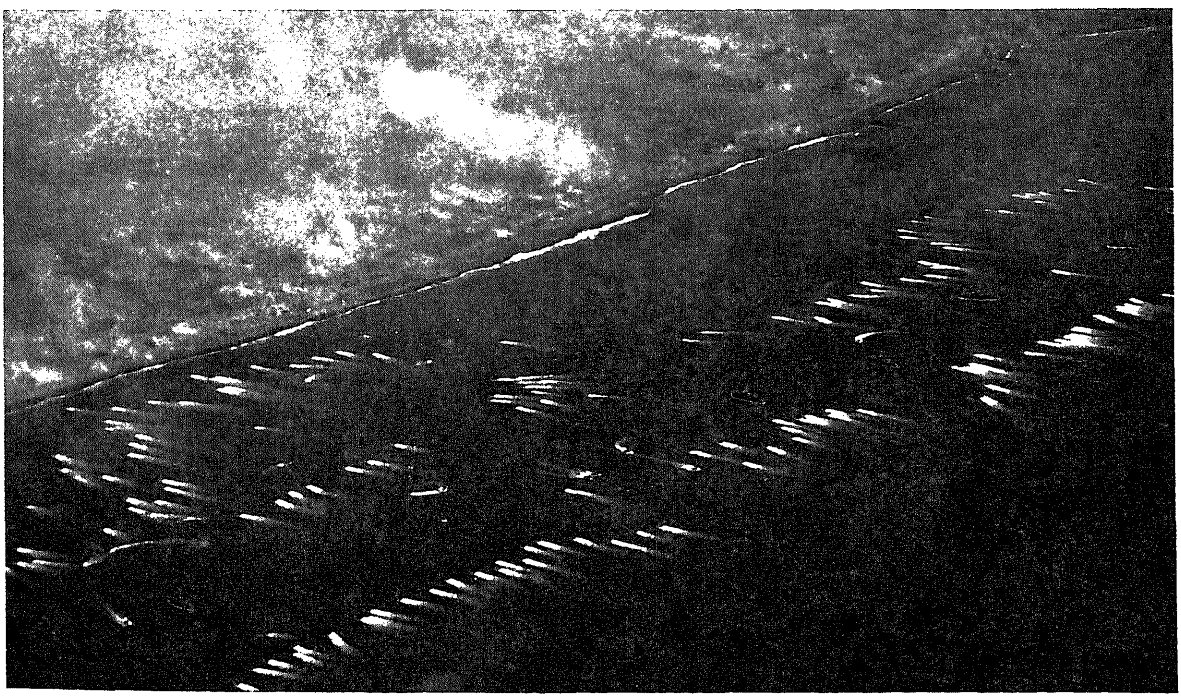

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Figure 12-11.—Shore bombardment intensifies as troop-laden assault craft approach the beach.

Establishing the Beachhead

At H-hour the first waves touch down, and the troops disembark (figure 12-12), disperse, and start toward their initial objectives. Operations are so directed as to rapidly establish a secure beachhead of sufficient extent to ensure the continuous landing of troops and material. It also provides the terrain features and maneuvering space required for initiating further planned objectives. During operations to capture the beachhead, intermediate objectives are designated to enable troop commanders to coordinate their efforts. An early juncture between the waterborne forces and troops landed by helicopter, parachute, or transport aircraft is desirable. Reserves of the assault units are landed as required to maintain the momentum of the attack.

LOGISTICS DURING THE ATTACK

During the assault phase, the logistic support system of the landing force is progressively developed, starting from a ship-based status. It proceeds through a period of decentralized support conducted through several beaches and landing zones and eventually consolidated into a single centrally controlled effort. Since the supplies and equipment carried by individuals and organizations in the initial landing are limited, a flexible, yet positive, system is established. This is to provide timely replenishment of supplies and to build up stocks ashore to sustain the assault and diminish the dependence of the landing force on supplies which are still afloat. During the initial stage of the assault, logistic support is provided from within beach support areas and landing zones. As the operation progresses, the functions carried out from these areas are consolidated and logistic support areas are established.

When logistic support areas are adequate and the assault has progressed to a point where there is reasonable security for logistic installations ashore, the landing force commander may recommend general unloading. After the amphibious task force commander gives the order to commence general unloading, all ships in the

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Figure 12-12.—The first wave of infantrymen comes ashore and starts toward its initial objective.

amphibious task force discharge their remaining cargo as rapidly as beach unloading conditions permit. The control organization for the ship-to-shore movement ceases to operate except for regulation of traffic, but remains substantially in a standby status, ready to resume selective unloading if required.

When, in the opinion of the landing force commander, the landing force is firmly established ashore and ready to assume full responsibility for subsequent operations and when mutually agreed upon with the amphibious task force commander, control of land operations is shifted ashore to the landing force commander. The amphibious operation is then terminated with the amphibious task force remaining in support until competent authority dissolves the amphibious task force and directs its forces to report to designated superiors or directs reembarkation of the landing force.

THE ROLE OF MERCHANT SHIPS[1]

Today, there are three active Marine Corps division/air wing teams and a fourth team in the reserve component. The total capacity of all our amphibious warfare ships could embark the assault elements of about one and one-third Marine division/wing teams. Allowing for ships in overhaul and other considerations, however, the maximum Marine Corps units that can be lifted by Navy amphibious shipping approximates the assault elements of one division/wing team. Therefore, both to enhance more timely large scale amphibious response and to permit effective early amphibious employment of something beyond one-third of the Marine Corps active force, merchant marine resources must be exploited.

The idea of using merchant ships to supplement amphibious shipping is not new. For many years the nonassault elements and logistic supply of the Marine forces have been planned for merchant lift. The Navy is adapting new merchant ship construction to these roles by developing portable ramps for RO-RO's and the Crane on Deck (COD) and Temporary Container Discharge Facility (TCDF) for containership unloading in secure areas.

What is new is the idea of using merchant ships to lift a significant part of the assault elements of the landing force using containerships and other intermodal carriers. Tests have been conducted to determine the adaptability of SEABEE and LASH ships to carry assault craft in the manner of an LSD. In a variation of the ARAPAHO concept, a containership could be converted into a troop transport by substituting modules fitted out as living quarters for cargo filled containers.

As there is little likelihood of any significant increase in dedicated amphibious lift capability, it is apparent that the U.S. flag merchant marine will continue to play an important part in any large scale Navy amphibious operations in the future.

[1]Vannoy, Frank W., "Where do the Gators Go From Here?" U.S. Institute Proceedings, March 1978.

CHAPTER 13

MINE WARFARE

Mine warfare may be divided into defensive and offensive mining and countermeasures. Defensive mines are planted to protect a nation's own harbors and shorelines. Offensively, mines may be used to bottle up enemy harbors, to render strategic or convenient shipping routes dangerous or even useless, and to make the enemy divert ships, equipment, and personnel to minesweeping chores. Spreading the minefields over as wide an area as possible and using several different types of mines makes the minesweeping problem more formidable, and safe shipping routes become more and more difficult to maintain. Offensive minefields also shunt enemy shipping through areas where it may be more readily attacked by friendly forces.

Countermeasures comprise all methods of clearing channels and fields of the enemy's mines for self-protection of ships.

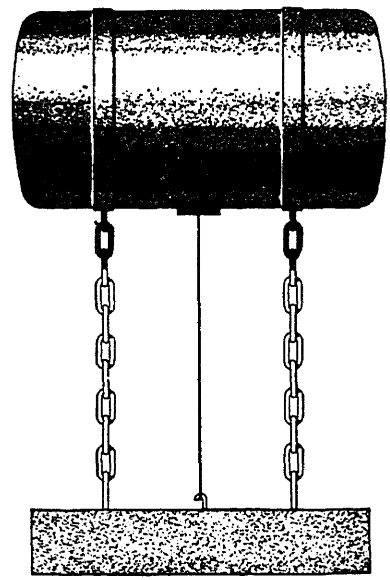

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Figure 13-1.—Confederate harbor mine.

HISTORICAL DEVELOPMENT

Although the mine (originally called a torpedo) did not come into general use until the Civil War era, efforts to produce an explosive charge that could be detonated under or against the hull of an enemy ship were begun in the early days of gunpowder. The progenitor of the modern mine was Bushnell's powder keg set adrift on the Delaware in December 1777, its target the blockading British squadron downstream. An unfortunate current and a mossbacked officialdom defeated this Yankee invention. It remains on record, however, as the first contact mine of the floating type to enter the American service.

Farragut's penetration of Mobile Bay remains one of the more dramatic episodes in the history of mine warfare. The Confederates blocked the wide entrance to Mobile Bay with pilings, which forced shipping to navigate a channel under the guns of Fort Morgan. This channel was planted with about 180 mines (fig. 13-1) strung out in lines designed to leave a narrow passage within pointblank range of the shore batteries. Left open for Confederate vessels, the passage was considered a deadly trap for the enemy invader whose ships would be squeezed between the "torpedo" lines and the fort. It was into this bottleneck that Farragut boldly ordered his Federal squadron.

As the squadron entered the bottleneck, Farragut ordered his ships to stay in deep water and to move steadily forward, making no turn until the torpedo line had been passed. Equipped with gear to pick up the mines, the *Brooklyn* led the parade of wooden warships. A column of monitors, led by the *Tecumseh*, moved on the flank. Someone mistook the orders, and the monitor *Tecumseh*, veering off to fire at a Confederate ironclad, struck one of the submerged mines. There was a thunderclap explosion, and the Federal monitor went down. The *Brooklyn* tried to turn away and blocked the

ıdvance. A hot fire from Fort Morgan raked the lisorganized line. Farragut heard the cry, 'Torpedoes!'' The old admiral shouted from his lagship's rigging, ''Damn the torpedoes! Full peed ahead!''

As the Federal warships pushed on, their crews ıeard the scrape of iron against keel and the napping of primers and kicked trigger ıechanisms. But the watchdogs failed to bite—.ot another torpedo exploded.

This use of mines to force enemy shipping ıto a channel covered by shore batteries was an arly demonstration of a mining tactic that later ecame standard. Given a more reliable model ith a better explosive device, the Confederates ıight have frustrated Farragut's attempt. With ne death-dealing exception, the Confederate ɔrpedoes proved to be duds. Long immersion in ılt water had caused them to deteriorate and had rawn their teeth. Thus was dramatized the roblem of mine deterioration, a baffler that ıodern science has not yet entirely solved.

Mines were considered only a defensive 'eapon until the Russo-Japanese War of 1904. 'he Japanese almost destroyed the entire Russian .eet by luring them into mined waters. This evelopment opened up a new use for mines, lthough it was not until World War I that ffensive use of mines came into being.

PERATIONS IN WORLD WAR I

During World War I both Allied and Central owers engaged in extensive mining operations. urkish mines laid in the Dardanelles frustrated British-French attempt to penetrate the Sea of larmora in March 1915. By fending off the llied thrust, the Dardanelles minefields enabled ıe Turks to strengthen their fortifications; as a ɔnsequence, the British drive on Gallipoli ended ı costly failure.

Throughout the war, German mines imperiled ritish shipping in the English Channel. British 'forts at offensive mining, notably in Heligoland ight, were frustrated by efficient German inesweepers supported by the High Sea Fleet. he clearing of enemy minefields became a ajor endeavor of the rival navies. The standard ine of the war was the spherical model studded ith warlike ''horns''—an anchored contact ine.

The Allies bottled up the German U-boats in e North Sea by laying a minefield from Scotland Norway (fig. 13-2). This allowed the Allies to e Atlantic shipping routes in comparative safety.

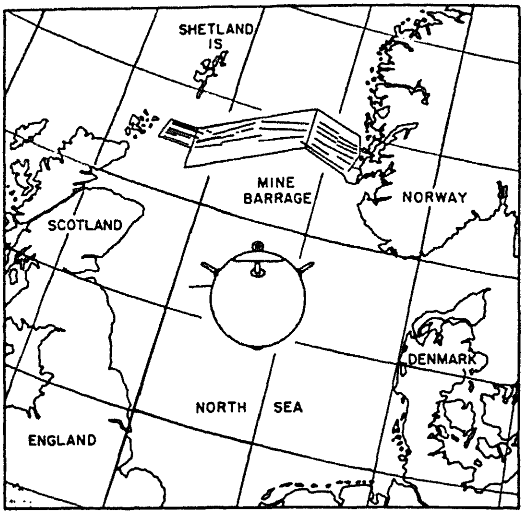

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Figure 13-2.—World War I mine and North Sea barrage.

Contrary to popular belief, more ships were sunk by mines than by torpedoes and gunfire combined during World War I.

OPERATIONS IN WORLD WAR II

Mine warfare of World War II featured submarine and aircraft mine plants. Defensive mining was carried out in the main by the conventional types of surface minelayers, and mine clearance was accomplished by surface craft with special minesweeping equipment. Countermeasures included novel devices for protection and detection. For the most part, the Allies were able to keep their mine losses within acceptably low limits.

In the opening months of the war, Nazi submarines and aircraft sowed deadly fields off the English and Scottish coasts. During November and December 1939, a number of British ships were sunk by this mine barrage, which was particularly heavy in the Thames Estuary. There the Allies encountered one of Hitler's secret weapons—an influence mine that was exploded by the action of a magnetic needle coupled to a detonating mechanism and activated by the magnetic field of a steel-hulled ship. The Nazis employed a variety of these mines. But the magnetic mine was hardly in action before the British produced successful countermeasures.

One of these countermeasures was the degaussing belt, a system of electrical cables

carried currents of electricity which neutralized the ship's magnetic field. During the war, the device developed as a major anti-mine shield for Allied shipping. Degaussing and sweeping together successfully countered the magnetic mine, and Nazi offensive mining operations were a disappointment to the Axis leaders.

That mines remained a dangerous threat to the last is evidenced by American ship losses off Normandy where three destroyers, a destroyer escort, two minesweepers, two transports, a submarine chaser, and a number of landing craft were sunk—most of them by mines.

In the Pacific, as in the Atlantic, the combatants employed minefields to defend their major bases and harbors, and laid offensive fields to destroy or divert enemy shipping.

U.S. submarines laid the first Allied offensive minefields in the Pacific in October 1942. For our submarines, minelaying was a secondary, but successful, enterprise. A total of 658 mines, laid by 34 submarine sorties, resulted in 43 reported Japanese ship casualties, of which 24 were sunk and 19 damaged. Submarine mining continued until May 1945, by which time profitable locations for such mining had almost disappeared.

The Japanese laid a vast minefield in the East China Sea, west of the Nansei Shoto; and throughout the war this field protected their shipping in that area. Japanese mines also were scattered in the Yellow Sea, and minefields effectively guarded the entrances to the Sea of Japan until the closing months of the war. The loss of three American submarines was almost certainly caused by mines, and five others that failed to return from patrol may have been destroyed by mines.

In March 1945 the 20th Air Force, using B-29 aircraft, began a mine campaign designed to end shipping in Japanese coastal waters. The major target was the Shimonoseki Straits. Eventually all important Japanese and Korean seaports were mined by the B-29s, and over 670,000 tons of shipping were sunk or disabled by this tremendous barrage. The Japanese were unable to clear the clogged channels. The mines (acoustic, magnetic, and pressure-magnetic) were not easily swept, and the Japanese lacked equipment for the task. Japan's war effort was expiring when the mining offensive was launched against it. Technologically weak to begin with, the Japanese were unable to produce first-class mine countermeasures. This operation was so successful that it almost stopped Japanese shipping completely. A side because Japan could not import enough food. This was the United States' largest and most successful use of offensive mining to date.

OPERATIONS IN THE VIETNAM CONFLICT

In May 1972 nine sorties of A-6 and A-7 aircraft dropped 36 mines in the channel of Haiphong in one of the most strategically effective operations of the Vietnam Conflict. None of the 29 trapped major merchant ships was sunk. However, those ships were out of action for the duration of the conflict. The effectiveness of the coastal mine campaign demonstrated the vulnerability of a country that has little or no minesweeping capability. Thus the mining campaign provided a potent lever to U.S. negotiations both before and after the peace agreement.

From the beginning, the possibility of U.S. forces having to sweep the mines was a factor that influenced the types of mines used, their settings, and, to a lesser degree, their locations. As a result, when the time came to sweep, we knew everything about the mines and had purposely planted mines that could be swept easily and effectively by our mine countermeasures forces. The vast majority of the mines were programmed to self-destruct and the remainder to become inert after a given time. Thus, even as the mines were dropped, the process of mine removal had been started.

TYPES OF MINEFIELDS

The subject of minefields is a very extensive one, and space is not available in this text to cover it fully. More detailed information can be found in the current edition of NWP 26.

A mine is designed to do the same job as a gun projectile or torpedo. The big difference is that mines are rarely used one at a time; a group of mines is used to make up a minefield. The two main purposes of these fields are first, to destroy or disrupt enemy shipping—both combatant and noncombatant; and second, to protect United States and Allied shipping and Allied-controlled territories.

The type of field in which mines are planted is dictated by the prevailing situation. The field type is chosen by an application of the potentialities of mines and planters to the problems which the situation presents.

Minefields may be divided according to purpose into two broad groups—defensive and

offensive—with variations to make them more effective.

Defensive Minefield

A defensive minefield is similar to a defensive football team in that they both try to hold back the opposition. Although defensive mining usually attempts to keep the enemy guessing at all times, in some cases the field is well advertised. This adds to the effectiveness of the field, because the enemy may decide against entering these waters because of the potential danger. The area may still be used by our forces and Allies who are provided with charts showing the mine-free navigable channels. Some of the specific ways in which mines may be used defensively are as follows:

1. In large harbors and anchorages for permanent harbor defense
2. To protect advance base anchorages
3. To protect assembly points for convoys
4. To protect coastal shipping lanes from seaward attack
5. As a submarine trap
6. As anti-invasion fields

Offensive Minefield

The offensive minefield—in keeping with our analogy—can be compared with a football team on the offensive; they both take the action to the opponent. These fields are planted in enemy-held or disputed waters to disrupt enemy shipping. Offensive minefields do this by destroying or damaging the enemy's ships, or by making areas unusable because the threat of losses is so great.

Offensive fields are subdivided into two groups—uncountered attrition and countered attrition on fields. Uncountered fields are those which the enemy is not expected to counter by minesweeping or hunting, and which are intended primarily to cause damage to enemy ships. Countered attrition fields are of two types: transitory fields and sustained attrition fields.

TRANSITORY ATTRITION FIELDS.— Transitory attrition fields are small, secretly planted fields laid in an area in which traffic is sufficient to give a reasonable probability of a casualty. From the meaning of transitory, obviously this field is designed to last only a short time. The field can be swept easily or avoided by the enemy, and mines that are destroyed are usually not replaced.

SUSTAINED ATTRITION FIELDS.— Sustained attrition fields are laid where they cannot be easily avoided by enemy traffic. They are maintained for a prolonged period of time by the replacement of those mines which have been blown up. If the casualty rate is so high that the enemy cannot afford the losses, the minefield can deny them the use of the channel or area.

Mines are an excellent STRATEGIC weapon in that mining operations can be carried out over a prolonged period without regard to other military activities. Mines destroy the enemy's war-making potential behind their own lines. On the other hand, a mine is a poor TACTICAL weapon because of the lengthy and detailed preparation necessary for planting a minefield. A tactical weapon is one designed for supporting or protecting a single engagement, and time usually does not permit the use of mines for this purpose.

The design of a minefield depends on the purpose of the field and on the countermeasures expected. They are divided into six types:

1. Countered fields are those which the enemy is expected to counter by minesweeping or hunting.
2. Uncountered fields are those which the enemy is not expected to counter by minesweeping or hunting.
3. Protective fields primarily protect what lies behind the field by hindering or preventing the enemy's approach.
4. Attrition fields are those intended primarily to cause damage to enemy ships.
5. Nuisance fields are those in which a few mines are laid to harass the enemy.
6. Dual purpose fields are those having more than one purpose.

MINE CLASSIFICATION

Mines are classified by types according to (1) the method of planting, (2) the mine's position in the water, and (3) the method of actuation (firing).

Classification by Method of Planting

Method of planting means the method by which mines are put into the water. There are three classifications of mines according to methods of planting: (1) surface-craft-planted, (2) submarine planted, and (3) aircraft planted.

Mines can be planted by surface craft when secrecy is not of prime importance. High-speed minelayers are usually used to do the job. A minelayer can carry a large number of mines and can lay a large minefield in a relatively short time. Presently, the Navy has no minelayers in commissioned service. In case of war, however, these ships could be reactivated in a short time.

Submarine-planted mines have an advantage over surface-craft-planted mines in that the mining operation can be accomplished with great secrecy and at great distances from home ports. One of their disadvantages is that once an area has been mined, it must be avoided for the armed life of the mines. Therefore, submarines cannot repeatedly mine the same area.

Aircraft-planted mines may be carried on the aircraft internally or externally, like bombs or torpedoes. Aircraft can carry mines into enemy-held areas, and the field can be replenished over a long period of time without danger from previously planted mines. This type of mine cannot be planted in secrecy, but aircraft can plant mines in enemy-held shallow coastal waters that cannot be mined by other means. Blockading of enemy shipping lanes can be very effectively accomplished by this type of mining (fig. 13-3).

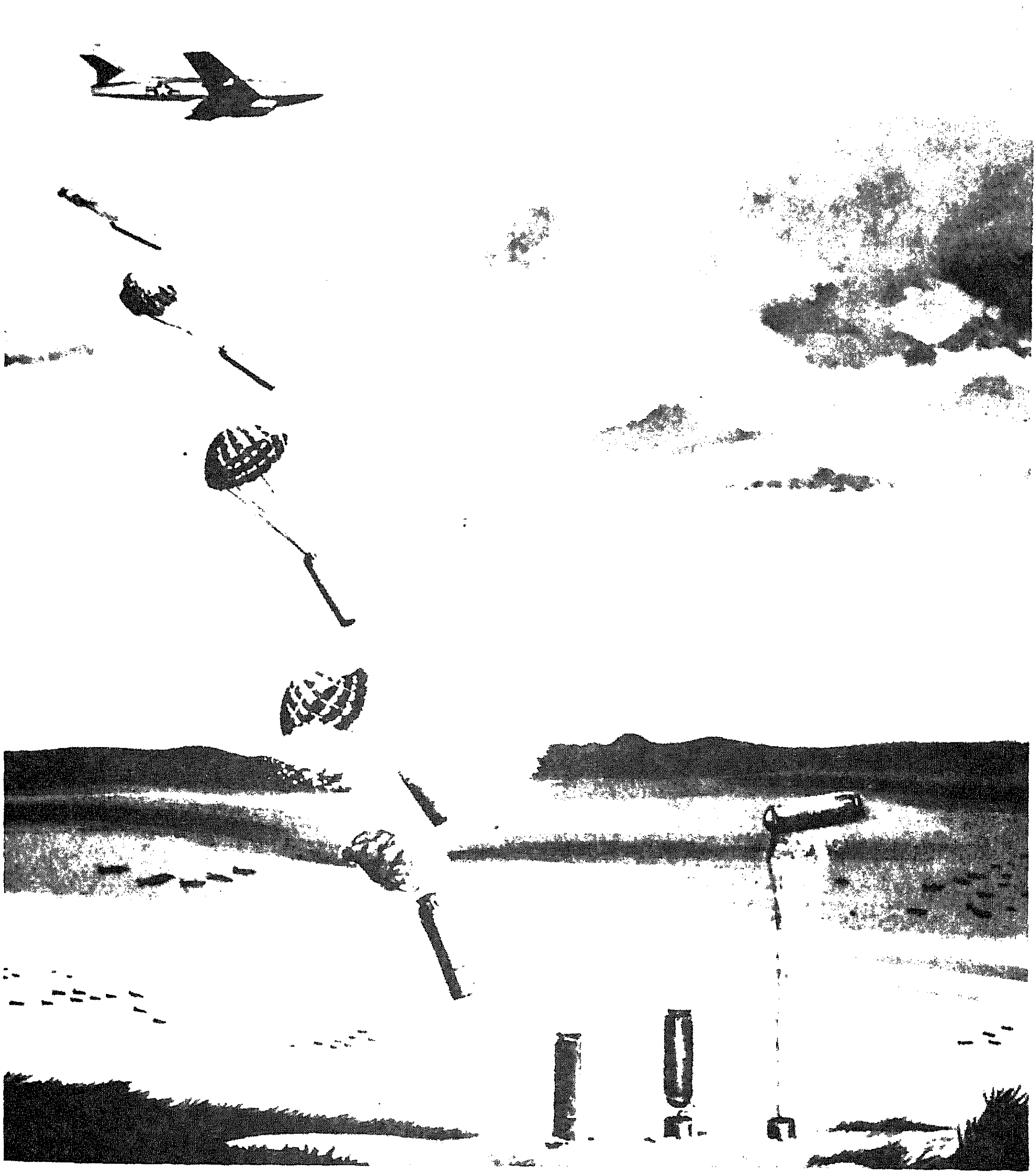

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Figure 13-3.—[illegible]

Although each mine is designed for planting by a particular method, and is so identified, aircraft- and submarine-planted mines may also be planted by surface craft when appropriate adaptations have been made. For limited operations, almost any ship or boat can be adapted to plant mines. This flexibility makes all types of mines available for surface planting.

Classification by Position in the Water

By their position in the water, mines may be divided into two categories—moored and bottom.

The moored mine has a buoyant case containing an explosive charge. The case is kept at a predetermined depth by a chain or cable attached to an anchor. This type mine may have either a contact- or influence-firing mechanism. Its main disadvantage is that it may be cleared with comparative ease by mechanical minesweeping gear. (This is the reason the bottom mine was developed.) The two most important advantages of the moored mine are that (1) it can be moored close to the surface so that it will be actuated by any ship or boat, no matter how small, which penetrates the minefield; and (2) it may be planted in waters which are too deep for bottom mines, since the case of a moored mine assumes a position some distance from the bottom. The maximum depth of water in which a moored mine can be planted is limited by the downward pull on the case caused by the weight of the cable and by the drag of tides and currents.

The bottom mine is held on the ocean's bottom by its own weight. It can be planted by surface craft, submarines, and aircraft; but normally surface craft are not used to plant bottom mines. This type of mine generally is not effective against surface ships when planted in waters more than 30 fathoms deep. They may be planted in deeper water, however, as antisubmarine weapons. Because this type of mine lies on the bottom, the enemy must use costly minesweeping gear to detect them. Also, the bottom mine is more difficult to detect with locating gear than the moored mine, especially when it lies in soft mud or a densely growth-covered bottom.

Classification by Method of Actuation

The third way of classifying mines is by the type of firing mechanism or device used to actuate them. The classification is subdivided into (1) contact and (2) influence mines.

CONTACT MINES.—At the time of this writing, the Mine Mk 53 Mod 0 is the only contact type mine in service use. It is an aircraft-planted moored mine that destroys enemy sweep gear on contact. When a sweep cable strikes the mooring cable, it pulls the case down until the sweep cable contacts the firing ring. The tension-firing mechanism fires the mine when the sweep cable pulls up against it.

INFLUENCE MINES.—Influence mines are much more complex than contact mines. They are fired by the close approach or passing of a ship. Bottom mines are of the influence type. This type uses several different means of actuation. It may be actuated by (1) sensitivity to the target ship's magnetic field, (2) by sensitivity to the ship's underwater sound, or (3) by sensitivity to the reduction of water pressure around the mine caused by the passing of a ship. We have mines which may use only one of the above means of actuation, but we also have mines which use a combination of all three. The influence mines have a larger target width and are much harder for the enemy to sweep than the contact mines. In fact, with combinations of firing mechanisms, the influence mine can be made almost impossible to destroy with minesweeping gear. A brief discussion of the different types of influence mines follows.

Magnetic Mines.—The magnetic mine is actuated by a change in the earth's magnetic field surrounding it. A steel ship intensifies the earth's normal magnetic field. This change in magnitude or direction of the field, if in the proper sequence, will actuate the firing mechanism. The magnetic firing mechanism is of the magnetic induction type.

The magnetic induction mechanism operates on the change of magnetic field of the mine. This mechanism depends primarily on the rate at which the field intensity changes, rather than on the amount of change. A small current is induced by a coil in the changing field. If sufficient potential is developed, a relay is actuated, closing the firing circuit. This type of mechanism is used in bottom mines in areas where ships are underway at normal speeds.

Pressure Mines.—This mine's firing mechanism is actuated by the change in water pressure caused by a moving ship. A passing ship momentarily increases the pressure as the ship's bow wave passes. This increase is followed by a

reduction in pressure for a sustained period (fig. 13-4). Contrary to popular belief, it is this reduced pressure, rather than increased pressure, that operates the mechanism. This mechanism is used only in bottom mines and only in areas where ships are underway at normal speeds. The pressure mechanism is probably the most difficult to sweep.

Combination Mines.—A combination of mechanisms improves the usefulness of a mine in that it is less likely to be actuated by false targets. Also it makes the mines harder to sweep. For the mine to fire, all the incorporated firing mechanisms have to be actuated within a specific time limit. The first mine of this type was pressure-magnetic. It was first used as an aircraft-planted bottom mine and later as a submarine-laid bottom mine. We now have mines that use a combination of all three types of firing mechanisms at one time. Once again, this improvement makes mines of this type almost impossible for the enemy to sweep.

LIFE CYCLE OF MINES

The life cycle of a mine follows the same pattern as that of a living thing. It can be said

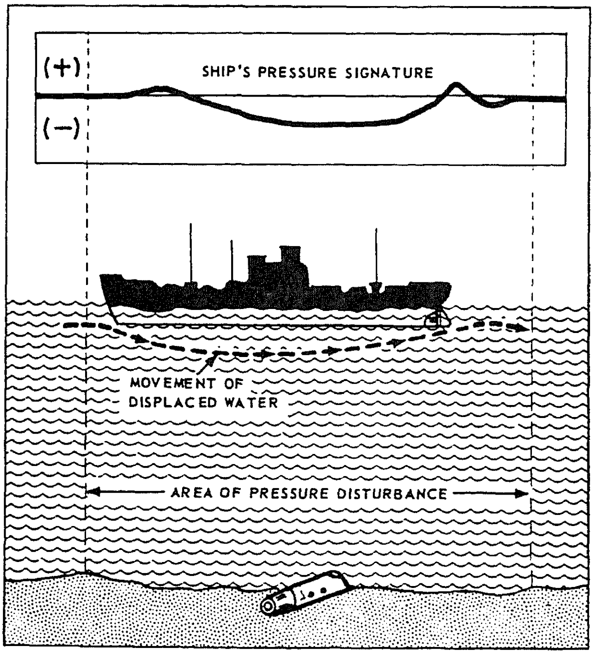

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Figure 13-4.—Pressure signature.

that a mine is born when it is planted and lives for the armed life set for it. It dies when it is exploded or when it is rendered safe by the sterilizer device. Because much of the life cycle is the same for all mines, only the influence type will be discussed briefly.

An influence mine is mounted on or in an airplane at its home base. At the proper time the plane will carry the mine to the area to be mined and drop it as it would a bomb. The mine has a parachute attached that slows it as it drops. When the mine hits the water, the parachute separates from the case, and both case and parachute sink to the bottom. The delay arming safety features start operating to arm the mine. Like the contact mine, this mine can be actuated by any ship; but in the case of influence mines, the ship has to meet certain specifications to actuate the firing mechanism.

MAJOR MINE COMPONENTS

The major components of a mine are the case, the explosive filler, the anchor (if one is used), and the firing mechanism with its accessories.

The mine case provides a watertight compartment for the main charge and the firing system. The bursting charge occupies the main compartment and, in bottom mines, will fill most of it. In moored mines, the case must be large enough to provide air space for buoyancy. Smaller compartments in the case house and secure the batteries, firing mechanism, and accessories.

Mine cases are usually made of steel, but a nonferrous metal is required when certain influence firing mechanisms are to be used.

Anchors for various moored mines naturally differ in size, shape, and method of operation. All must be capable of mooring the mine at a preset depth below the surface. For ease in handling, the anchor is assembled integrally with the case.

MAJOR MINE ACCESSORIES

Mine accessories and components are devices contained within an assembled mine case to make the mine a safe and reliable weapon. The many accessories and components available are too numerous to be included in this text; therefore, we will include only some of those most commonly used.

1. HYDROSTATIC SWITCHES are used to close electric contacts by means of hydrostatic pressure working against spring pressure.

2. The ARMING DEVICE is an extender and hydrostatic switch assembly that aligns an explosive train and operates electrical contacts when subjected to hydrostatic pressure.

3. CLOCK DELAY mechanisms delay the arming of the mine for a preset time after planting. This allows the planting craft time to plant a large minefield before the mines become dangerous. Clock delays are also used to stagger the arming of mines in a field to improve its effectiveness. Clock delay mechanisms are of two basic types: hand wound and motor wound. Hand-wound clocks may be set to provide a delay in arming of 1/2 to 10 days; motor-wound clocks provide a delay of 3 to 100 days.

4. The STERILIZER mechanism is used to limit the armed life of a mine to a predetermined time. It renders the mine inoperative by shorting out the battery or, in some cases, by opening the detonator circuit.

5. BATTERIES used in mines are of the dry cell type. Each is composed of several cells arranged in a waterproof container. The batteries provide the required voltages and current to operate the mine accessories and the firing system to fire the detonator at the proper time.

6. The ACTUATION COUNTER (sometimes called a ship's eliminator or ship's counter) is designed to delay firing the detonator until the firing mechanism has completed its operation a predetermined number of times.

7. SEARCH COILS are used in magnetic induction mines to detect changes in the earth's magnetic field around the mine.

8. The MICROPHONE or HYDROPHONE contains a crystal that changes sound energy into electrical energy to actuate the acoustic firing mechanism.

9. The CONTROL BOX is a device that performs switching and timing functions. It ensures that certain requirements are met before the mine will fire.

10. SENSITIVITY SWITCHES are provided to adjust the sensitivity of the firing mechanism of a mine for best use against an intended target.

11. HYDROSTATIC RELEASES are mechanisms used to release a device from a mine or to separate two cables at a predetermined depth.

12. PARACHUTE PACKS are metal or plastic-and-canvas containers holding a parachute that is used to reduce the impact velocity of an aircraft-laid mine when it enters the water. This protects other mine accessories from damage that would result if the mine were allowed to fall freely

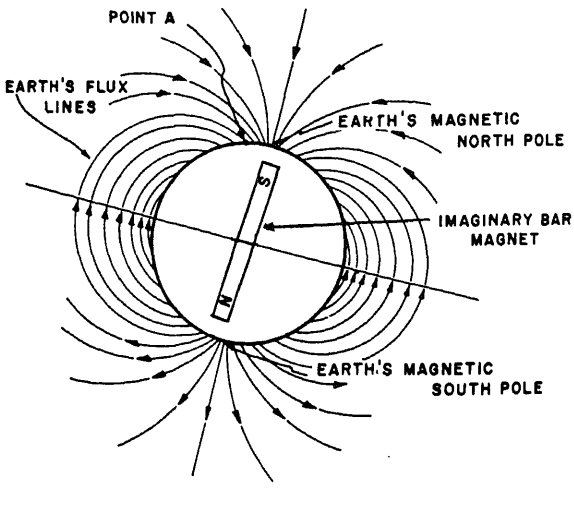
MINELAYING

A sudden massive attack by minelaying aircraft is considered to be one of the greatest threats to any maritime power that exists today. So great, in fact, that the possibility of such an attack requires major expenditures of manpower and equipment in conducting countermeasure operations, whether a single mine has been laid or not.

Offensive minelaying by surface craft has comparatively limited application in enemy-held waters. The utmost secrecy can, of course, be obtained by submarines laying the mines. However, a submarine cannot replenish the interior of an existing minefield without itself being exposed to an unacceptable amount of danger. That brings us to the use of aircraft. The aircraft naturally leads in its ability to lay mines suddenly and in great quantity. It is, further, as mentioned earlier, the only craft capable of replenishing a large existing field without danger from the field itself. Offshore shipping lanes can be mined by bombers and patrol planes whenever the depth of water is not too great. Mining of enemy-held rivers and harbors would generally be effected by tactical aircraft under conditions of low visibility or under cover of diversionary raids.

MINE COUNTERMEASURES

Mine countermeasures (MCM) include all actions taken primarily to protect own or friendly shipping against mines, including (1) reducing the effectiveness of enemy mines, and (2) clearing areas mined by friendly forces, after these areas have served their purpose. The three major types



of mine countermeasures are ship treatment (against magnetic and acoustic mines), mine hunting, and minesweeping.

Ship Treatment Against Magnetic Mines

Two principal methods (deperming and degaussing) of treating a steel ship hull are used to decrease the magnetic effects that actuate magnetic mines. Before discussing these, let us consider in more detail the characteristics of a ship's magnetic field.

Any ship's magnetic field can be analyzed into two main components—its permanent field and its induced field.

PERMANENT MAGNETIC FIELD.—When a ship's hull is being fabricated in a shipyard, it is subjected to heat (welding) and to impact (riveting). Ferrous metal contains groups of iron molecules called "domains." Each domain is a tiny magnet and has its own magnetic field with a north and south pole. When the domains are not aligned along any axis, but point in different directions at random, there is a negligible magnetic pattern. However, if the metal is put into a constant magnetic field and its particles are agitated (as they would be by hammering or by heating), the domains tend to orient themselves so that their north poles point toward the south pole of the field and their south poles point toward the north pole of the field. All the fields of the domains then have an additive effect, and a piece of ferrous metal so treated has a magnetic field of its own. You can demonstrate this by hammering on an unmagnetized piece of steel, such as a knife blade, in a strong magnetic field; the steel will develop a permanent field. The effect occurs (though to a lesser extent) even if the magnetic field is not strong. Although the earth's magnetic field is not strong, a ship's hull contains so much steel that it acquires a significant and permanent magnetic field during construction.

INDUCED MAGNETIC FIELD.—Imagine a magnetic field as consisting of many tiny "lines of force"[1] running from the magnetic north pole to the magnetic south pole of the field in a closed loop. The earth has such a field, as if it contained a huge bar magnet (fig. 13-5). The magnetic poles do not coincide with the geographic poles, however. Visualize an area of the earth's surface, with the invisible magnetic lines of force more or less evenly distributed over it. Air and water have low magnetic permeability; that is, they do not conduct magnetic lines of force (or magnetic flux) especially well. Now put a ship's hull into the sea at the point being considered. Ferrous metal has relatively high permeability. The high-permeability hull distorts the field because the magnetic lines of force tend to concentrate in it. If the ship is pointed toward magnetic north, the effect is as show in figure 13-6, view A; if the hull is pointed eastward, the effect is as shown in view B of the figure.

The distortion of the earth's magnetic field (as part of it concentrates in the magnetically permeable hull) is the induced field. As figure 13-5 shows, however, the magnetic lines of force of

[1]The idea of "lines of force" is intended only to aid you in thinking of the effects of magnetic fields. Their existence has not been physically demonstrated; the idea should be considered only as a conceptual convenience, not as a physical fact.

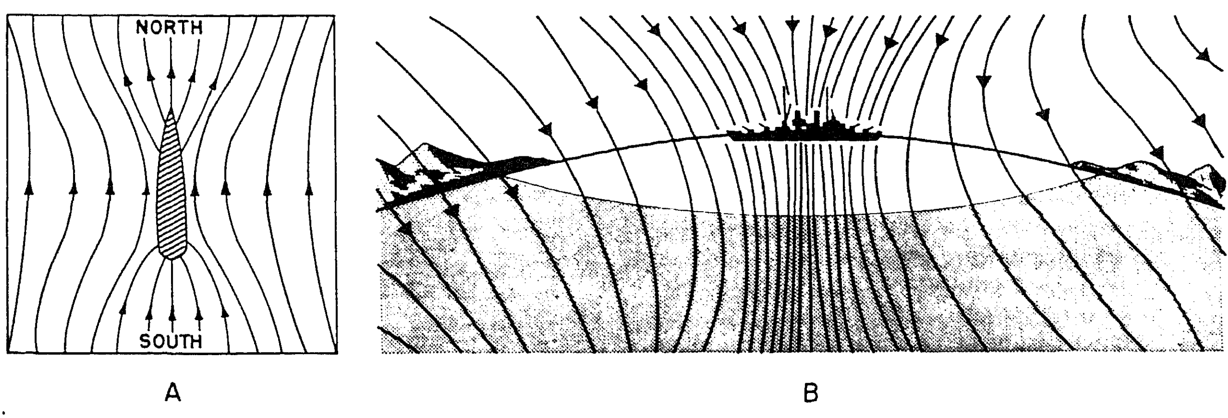


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Figure 13-6.—A ship's hull distorts the earth's magnetic field.

the earth's field are not parallel to the earth's surface except in the vicinity of the equator. Elsewhere they are tilted with respect to the surface; at the magnetic poles they are perpendicular. The induced field therefore has a vertical component as well as horizontal. The strength of the vertical component is affected chiefly by the ship's location on the earth with respect to the magnetic poles. Figure 13-6 illustrates the latter effect.

DEPERMING.—The purpose of deperming is not to eliminate a steel hull's permanent magnetic field altogether (this is not practical on a large scale), but to (1) reduce it to a minimum, and (2) make it more or less similar to others of the same hull type. At a number of locations called magnetic or degaussing ranges, magnetic sensing devices located on the bottom of a channel can detect a ship's magnetic field pattern as it steams past. The recording made of the ship's magnetic pattern is called its magnetic signature. After deperming, a ship's permanent magnetic field has not only been reduced to a practicable minimum, but its signature is similar to that of other depermed ships of the same class. The degaussing installation (described below) can then be set up on a "mass production" basis. The deperming process cannot be described here in detail; suffice it to say it is essentially a large-scale version of the process for demagnetizing a watch.

DEGAUSSING.—The term *degaussing* is derived from *gauss*, the unit of magnetic field strength (in turn, the name of this unit commemorates the German 19th-century mathematician Karl Friedrich Gauss). The purpose of degaussing is to counteract the ship's magnetic field so that (ideally) the magnetic field near the ship is the same as it would be if the ship were not there. To some extent this can be done by magnetic treatment of the ship by the use of coils temporarily installed. This is not as effective as the more frequently used method—the use of permanently installed equipment. The functions of the permanently installed equipment are as follows:

1. Degaussing coils
2. A dc power source to energize the coils
3. Means to control the currents in the coils
4. Magnetic compass compensating equipment cancel out the disturbing influence of the degaussing equipment on the magnetic compass

Since degaussing cannot be exhaustively described in this text, we will cover only some of the high points. The interested student is referred to the NAVSHIPS technical manual.

The ship's magnetic field (permanent plus induced) can be analyzed into six components. The degaussing installation is designed to produce as accurately as possible an exactly opposing field. The hull or other parts of the ship's structure are encircled by coils of heavy electric cable to produce the opposing field. The coils are designated as M (main coil), F (forecastle), Q (quarterdeck), L (longitudinal), and A (athwartship) (fig. 13-7). Various combinations of these are energized as required to create the desired fields. The coils are excited either by the ship's dc supply or by a motor generator that produces the direct current required. The polarity and current in each coil may be manually controlled; but

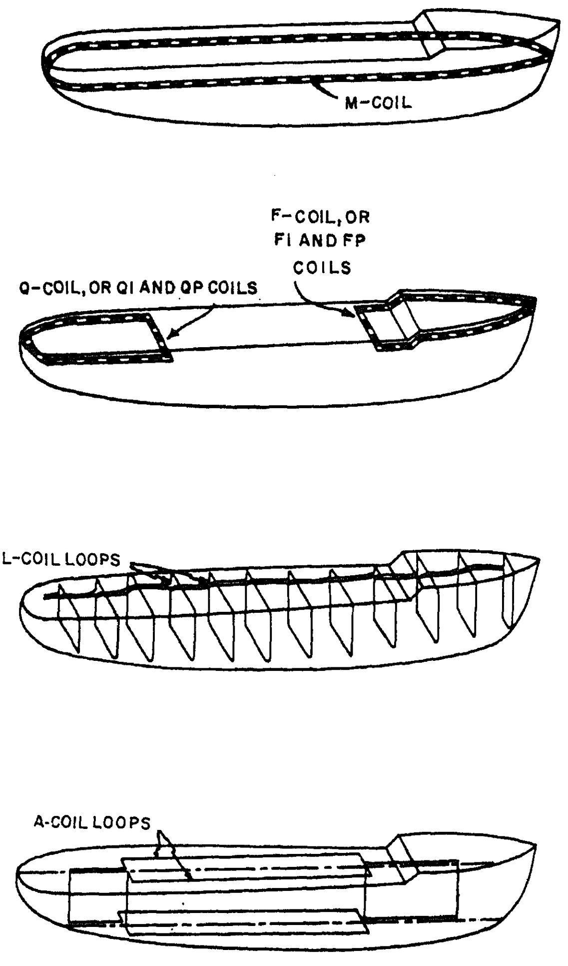

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Figure 13-7.—Degaussing coils.

the present trend is to make the functioning of the system completely automatic, except for manual setting of magnetic latitude and magnetic variation; that is, the difference between the direction to the geographic pole and to the magnetic pole. Such a system may compensate for ship's heading only or for heading, roll, and pitch by using servos to vary the dc inputs to the coils.

As effective as deperming and degaussing are, residual magnetic fields accompany all steel-hull ships, especially larger ones. For such critical work as minesweeping, more drastic antimagnetic measures are necessary. Minesweepers, therefore, may be built with nonmagnetic hulls to reduce magnetic effects to the vanishing point.

Ship Treatment Against Acoustic Mines

Acoustic mines function in response to the underwater sound output of ships. Most underwater noise of ships is caused by movement of the screw blades with respect to the water. At high screw speeds parts of the screw move so fast the water cannot flow around the screw edges fast enough, causing low-pressure areas to form and then collapse. These low-pressure areas actually are cavities or bubbles of water vapor, and their rapidly repeated formation and collapse produces water vibration at sonic or subsonic frequencies. Other causes of ship noise are vibration of external parts in the water as the ship passes through, water flow over sharp surfaces or obstructions of the hull, and transmission of machinery noises through the hull, screws, and screw shafting to the water.

The only important design change that could materially change acoustic disturbances caused by ships would be the development of a screw shape that would reduce cavitation or cavitation noise at high speed. Research is now under way on this. For the rest, once the ship's hull has been adequately faired, little can be done so far as design is concerned to reduce acoustic noise output. Noise can be reduced only by reducing screw speed and shutting down noise-producing machinery, such as reciprocating pumps.

Mine Hunting

The methodical detection, location, and neutralization of mines is appropriately called mine hunting. Some craft and their highly trained personnel specialize in this work. In mine-hunting, an area is searched with mine-detecting equipment. When a mine is located, it is then removed by divers or destroyed by explosive charges.

Minesweeping

In minesweeping, an area is searched with mechanical sweeps which physically remove the mines (for example, by cutting mooring cables of moored mines) and with influence sweeps which provide the influence fields necessary to actuate influence mines. In addition to minesweeping ships and craft, helicopters are used to sweep mines.

With less emphasis being placed on minesweeping ships, the helicopter has been developed into an effective minesweeping vehicle for coastal operations. Inherent characteristics that make the helicopter attractive as an MCM vehicle are its speed, safety, maneuverability, flexibility, and freedom from sea limitations. The characteristics, however, that limit its effectiveness include payload and weight restrictions, relatively short time on station (fuel capacity), and crew endurance. With the development of specialized minesweeping equipment which can be streamed and recovered from the air and with the advent of larger, more sophisticated helicopters which are capable of lifting loads of large volume and weight and which have good towing capability, the airborne MCM has assumed a major role in countering the sea mine, particularly in shallow waters.

Sweeping Moored Mines

The U.S. Navy uses several types of sweep gear for sweeping moored mines. In the most common type, a wire cable (sweep wire) is towed through the water deep enough to strike the mine mooring. The mine mooring then slides along the sweep wire until it engages one of several cutters spaced at intervals along the sweep wire. The cutter severs the mooring, and the mine bobs to the surface where it can be detonated or sunk by gunfire. The sweep gear can be streamed to both sides of the ship simultaneously.

Minesweeping cutters are either mechanical or explosive. A mechanical cutter has no moving parts and cuts the mine mooring by means of two saw-toothed blades held in the form of a V; it will cut wire moorings up to 1/2 inch in diameter, but will not cut chain moorings. Explosive cutters are of two types. One uses a shaped charge to cut the mine mooring; with the other type an explosive

charge propels a cutting chisel. Some explosive cutters are capable of severing chain moorings up to 1 1/8 inches in diameter.

Sweeping Magnetic Mines

As defense against magnetic mines, minesweepers are constructed of wood and stainless steel, aluminum, and other nonmagnetic metals that, along with an elaborate degaussing system, give them a low magnetic signature. A shallow draft also greatly reduces the danger to the minesweeper of moored or pressure mines.

To sweep magnetic mines, the minesweeper streams a buoyant cable (tail), many yards astern or to the side of the vessel, through which a powerful direct current is pulsed at intervals. This sets up a large magnetic field around the cable and influences the mines.

Helicopters use the Mk 105 hydrofoil sled when sweeping magnetic mines. The sled, towed through the water by a cable attached to the helicopter (fig. 13-8), has a turbine and generator mounted on it to generate power for a magnetic tail trailed behind the sled much in the same manner as the minesweeping ship. The major disadvantage in using the Mk 105 sled is the requirement for a support ship or shore-based unit to assist in streaming and recovery.

Sweeping Acoustic Mines

Sweeping acoustic mines is similar to magnetic minesweeping in that the effect of an approaching ship must be produced artificially. The effect is produced by a noisemaker, of which there are numerous types, towed astern of the sweeper. In one commonly used type, a direct current motor actuates a hammer that strikes a diaphragm to produce sound waves. Current to the motor may be pulsed or modulated to give the effect of an approaching ship. The approaching effect is vital because a sudden, sharp noise, such as an explosion, will not fire the mines. It merely actuates a countermine bypass circuit designed to prevent a mine from being fired by the explosion of an adjacent mine or depth charge. The acoustic hammer is supported by a large float and is towed about 1,500 feet astern. This is also true of helicopter-towed acoustic gear.

Sweeping Combination Mines

When helicopters are used in the sweeping of combination mines (acoustic and magnetic), the Mk 105 magnetic sled and Mk 104 acoustic gear are combined to accomplish the task simultaneously.

Sweeping Pressure Mines

Unable to produce artificially the effect that would detonate pressure mines (that of a ship passing over), the Navy converted a merchant ship for that purpose. Operational for only a short time, it was decommissioned and scrapped. The search for a positive method to sweep pressure mines continues.

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Figure 13-8.—The Mk 105 magnetic sled being towed by a helicopter.

CHAPTER 14

ELECTRONIC WARFARE

Electronic warfare (EW) is a rapidly growing field that is demonstrating its vital influence on both tactical and strategic decisions. Although the beginning of EW dates back to World War I, the events of the past few years (that is, Vietnam and Middle East wars) and recent technological advances have rapidly accelerated the development of this facet of modern warfare.

For many years there was wide misunderstanding of electronic warfare because of the classified nature of the subject and a variety of definitions. The basic understanding that has been adopted by this text is that electronic warfare is military action involving the use of electromagnetic energy to determine, exploit, reduce, or prevent hostile use of the electromagnetic spectrum and action which retains friendly use of the electromagnetic spectrum.

DIVISIONS OF ELECTRONIC WARFARE

There are different divisions of electronic warfare (fig. 14-1). These divisions are as follows:

1. Electronic warfare support measures (ESM) is that division of EW involving actions

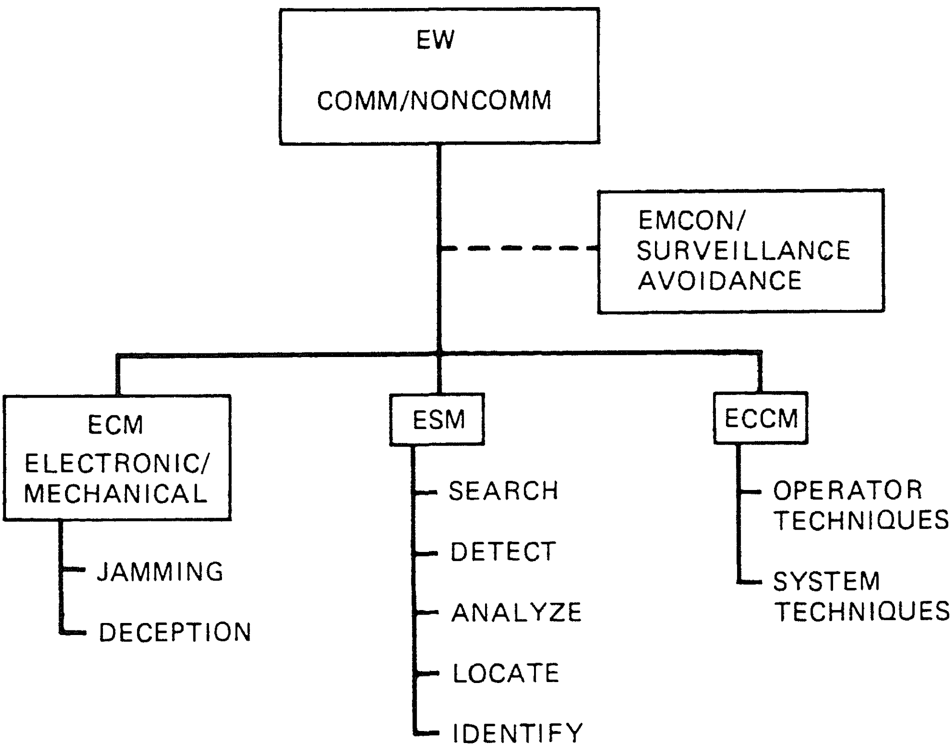

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Figure 14-1.—Functional relationships within electronic warfare.

taken to search for, intercept, locate, record, and analyze radiated electromagnetic energy for the purpose of exploiting such radiations in support of military operations. Thus, ESM provides the EW information required to conduct electronic countermeasures (ECM), electronic counter-countermeasures (ECCM), threat detection, warning, avoidance, target acquisition, and homing.

2. ECM is that division in EW involving actions taken to prevent or reduce an enemy's effective use of the electromagnetic spectrum. ECM includes the following:

a. Jamming—the deliberate radiation, reradiation, or reflection of electromagnetic energy with the object of impairing the use of electronic devices, equipment, or systems being used by an enemy.

b. Deception—the deliberate radiation, reradiation, alteration, absorption, or reflection of electromagnetic energy in a manner intended to mislead the enemy in the interpretation or use of information received by his electronic systems. There are two categories of deception.

(1) Manipulative—the alteration or simulation of friendly electromagnetic radiations to accomplish deception.

(2) Imitative—introducing radiation into enemy channels, which imitates his own emissions.

3. ECCM is that division of EW involving actions taken to ensure friendly effective use of the electromagnetic spectrum despite the enemy's use of EW.

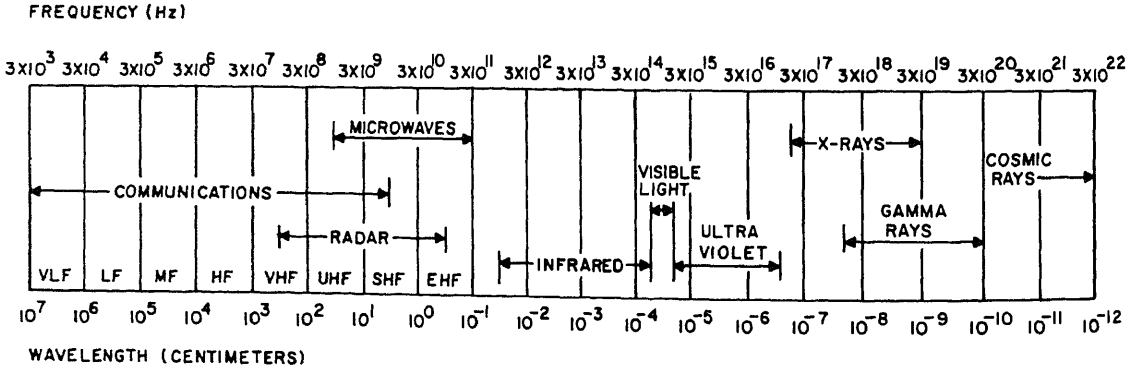
It should be noted at this point that electronic warfare is really dependent on the radiation of electromagnetic energy and not solely on *electronics*. Hence EW includes systems using all forms of electromagnetic energy (for example, radio, radar, infrared [IR], optical systems, lasers) with one major exception. Radiation produced by nuclear weapons is usually classed as nuclear effects and not EW (fig. 14-2).

ACTIVE/PASSIVE EW

Electronic warfare is often discussed in terms of active and passive roles. Passive electronic warfare is the search for and analysis of electromagnetic radiations to determine existence, source, and pertinent characteristics of the enemy's use of the electromagnetic spectrum. Active electronic warfare is the radiation or reradiation of electromagnetic waves to impair the enemy's use of electronic equipment or to mislead the enemy in the interpretation of data received from his electronic devices. In general, ESM is passive electronic warfare, ECM is active electronic warfare, and ECCM may be either.

ELECTRONIC SUPPORT MEASURES

The primary role of ESM is to detect, locate, identify, and evaluate electromagnetic transmissions for the purpose of immediate threat recognition. Detection is accomplished by a variety of electronic intercept receivers, which among them cover the entire electromagnetic spectrum.



Detected signals are analyzed for their transmission characteristics and evaluated for identity, purpose, and possible threat. A radar signal, for example, is analyzed for its frequency, pulsewidth, pulse repetition frequency, beamwidth, type of scan, antenna rotation rate, and so on. The characteristics are then compared to known signals and identified if possible (fig. 14-3).

With prior, adequate electronic intelligence, a hostile platform (that is, ship, land base, aircraft, and so on) can be located and identified by the electronic emissions. Weapon launch preparations, when a weapon is fired, and what type of weapon is fired (and therefore its attack characteristics) can also be identified. Obviously this information is extremely important in defending a formation and in making the decision to attack.

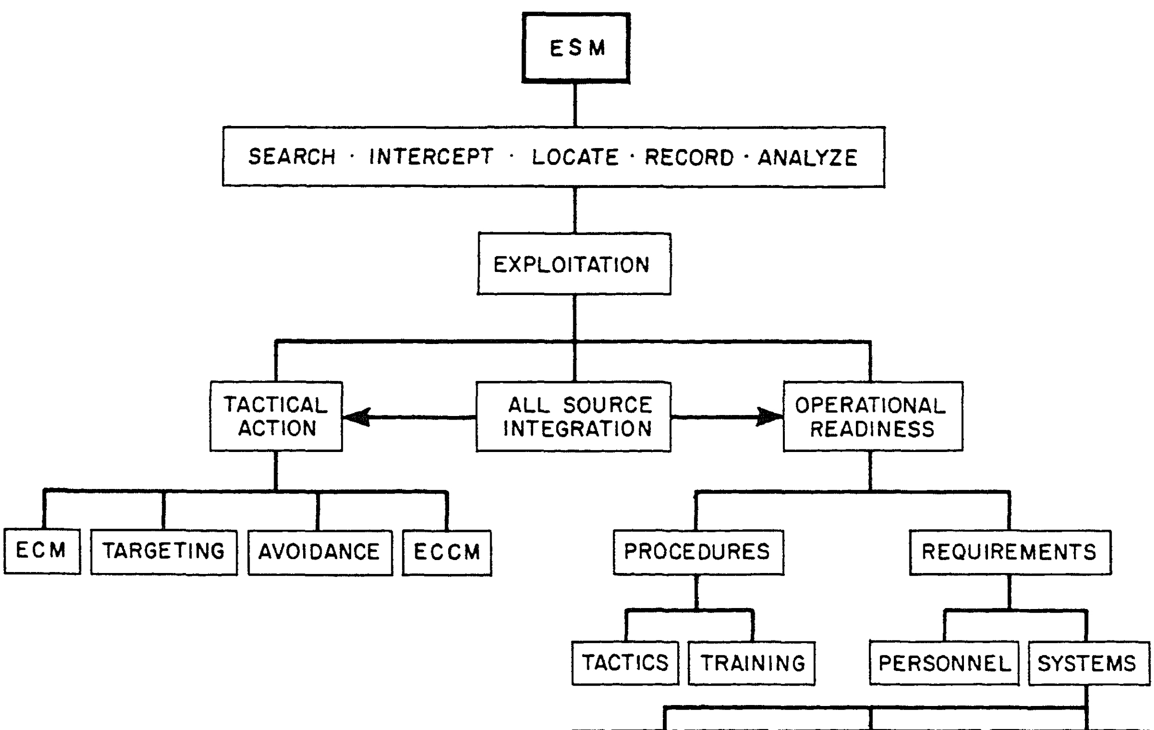
It is also valuable to note that ESM techniques may be used with impunity as they use receivers that emit no electronic radiations of their own, and, therefore, will not yield any information to enemy ESM efforts.

RECEIVER REQUIREMENTS

As mentioned above, the ESM receiver system is designed to intercept many different electromagnetic signals. Ideally the receiver system should be able to accomplish the following:

1. Intercept a transmitted signal at any frequency.
2. Determine the types of modulation in the signal.
3. Identify the usable intelligence carried by the signal.
4. Accurately measure the direction of arrival of the waveform so that the location of the transmitter can be calculated.
5. Process and preserve the signal characteristics for later in-depth analysis.
6. Provide the necessary significant information to the operator (and/or computer) to enable that person to make intelligent and timely mission decisions.

This list can be condensed into the generalization that an ESM receiver system must *gather*,



ocess, and *display* all signals of interest to meet specific mission requirements.

MISSION CONTROL

Since ESM relies on the radiation of energy, e easiest method of defeating the enemy's ssive electronic surveillance efforts is to reduce eliminate all electromagnetic or acoustic nissions. This deliberate management of equip- ent capable of producing electromagnetic or oustic energy is termed emission control MCON).

The *silencing* of all emitters on a ship or in formation complicates an enemy's attempt to cate and identify friendly forces. Total electronic d acoustic silence may allow a striking force to hieve surprise or permit a convoy to pass enemy rces undetected. This points out why it is so portant for merchant ships to maintain radio ence if at sea when hostilities commence. sing the electronic spectrum at such a time may ing unwanted attention.

There are inherent disadvantages to complete ectronic silence. A friendly force cannot obtain e overall tactical picture, coordination and ntrol are reduced, and a formation in total ence runs the risk of being surprised by the anticipated arrival of enemy forces that are also forcing strict EMCON procedures.

LECTRONIC COUNTERMEASURES

Through the use of passive ESM receivers, we in intelligence but do not limit the enemy in any ay. Electronic countermeasures (ECM) are the tive steps taken to hinder or render the ectromagnetic spectrum useless to hostile forces. e will discuss obvious advantages to the use of CM. These must be weighed against the certain owledge that your position is revealed to the emy by their use.

The emphasis of ECM employment in this ction will be employment against sensor systems. owever, some mention of the theory and prac- e of employing ECM against communications stems is considered appropriate, particularly in e contemporary Navy, which is so heavily pendent upon communications including the rious TDS links that provide the backbone to e fleetwide command and control efforts.

Strategically it may be undesirable to employ CM against an enemy communications system; r by doing so, one denies valuable intelligence at may be gained from eavesdropping on the stem. Tactically, however, it may be very vantageous to jam the enemy communications system to cause a breakdown in the battle plan. This was vividly illustrated during the 1973 Middle East War when the Egyptians successfully jammed the Israeli UHF/VHF radio frequencies. This resulted in a complete disruption of the air-to-ground communications and, consequently, a significantly reduced effectiveness of their close air support.

Typical electronic sensors against which ECM might be used include: radar warning picket ships; airborne radar patrols (AWACS); long-range, early-warning radar sets; ground controlled intercept radar sets; fighter intercept radar; missiles guided by radar or infrared; radio and radar navigation equipment; electronic bombing equipment; electronic identification equipment (IFF); terrain following radar; antiaircraft artillery (AAA); fire control radar; surface-to-air-missile (SAM) control radar; and so on. The particular method of employment will depend upon the tactical situation.

BASIC PRINCIPLES OF ECM

The basic idea of ECM is to interfere with the operation of the sensors of the air/surface defense system, and through them, to interfere with the operation of the system itself. Briefly, ECM attempts to make the defense more uncertain as to the threat it faces. The greater the defense uncertainty, the more effective the ECM. To state this principle another way, ECM attempts to reduce the information content of the signals the defense receives with its sensors. The objective of ECM, then, is to force the air/surface defense system to make mistakes or errors.

So, since we want to interfere with an enemy air/surface defense radar, how may we go about it? In general there are three fundamental ways, and each designates a class of ECM.

1. Radiate active signals to interfere with the radar.
2. Change the electrical properties of the medium between the aircraft/ship and the radar.
3. Change the reflective properties of the aircraft/ship itself.

The first class encompasses most jamming and deception. The second includes such techniques as chaff dispersion. The third class includes radar absorbing materials applied to aircraft and, conversely, both electronic and mechanical echo (blip) enhancers for decoys (fig. 14-4).

Burnthrough

Before delving into the individual ECM techniques, one final principle needs to be discussed, that of radar burnthrough. The principle of burnthough is usually stated as the range at which the strength of the radar echo becomes greater than the ECM signal. This phenomenon occurs for a large number of radar antennas.

If the ECM signal originates at the target, then it must travel the exact same path to the radar receiver that the target echo does. Thus, if it is to be stronger than the echo at the receiver, it must also be stronger when they both leave the target. Therefore, the power transmitted by the ECM transmitter must be greater than the reflected radar energy at the target. Typically, ECM transmitters radiate a constant amount of power, but as the target approaches the radar, the strength of the radar echo increases because the range is decreasing. Since ground/surface radar transmitters are more powerful than airborne or small craft ECM transmitters, there is a range at which the radar echo becomes equal in strength to the ECM signal. That range is the burnthrough range.

Jamming

It is now possible to turn to a detailed discussion of jamming.

Noise jamming—One way of preventing a radar receiver (or any other receiver) from functioning correctly is to saturate it with noise. Noise is a continuous signal and is dissimilar to the radar signal. The radar signal or echo is a periodic sequence of pulses. Figure 14-5 shows the radar echo first and then the echo with the jamming superimposed. The objective is to conceal the echo. As figure 14-5 illustrates, this means that the average amplitude of the noise must be at least as great as the average amplitude of the radar echo to be concealed. This idea can be alternatively expressed by saying that the average power of the jammer must have the same effect as the peak power of the radar echo, or it can be expressed by saying that the noise-to-signal ratio at the input is raised to a level beyond which the receiver can extract intelligence.

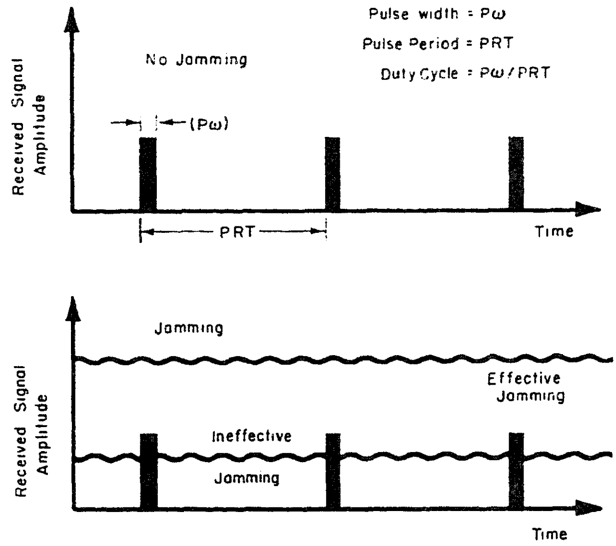


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Figure 14-5.—Radar signals with and without jamming.

Since the jammer must transmit energy continuously while the radar transmits energy in pulses, the jammer requires large average power. This large average power requirement in turn

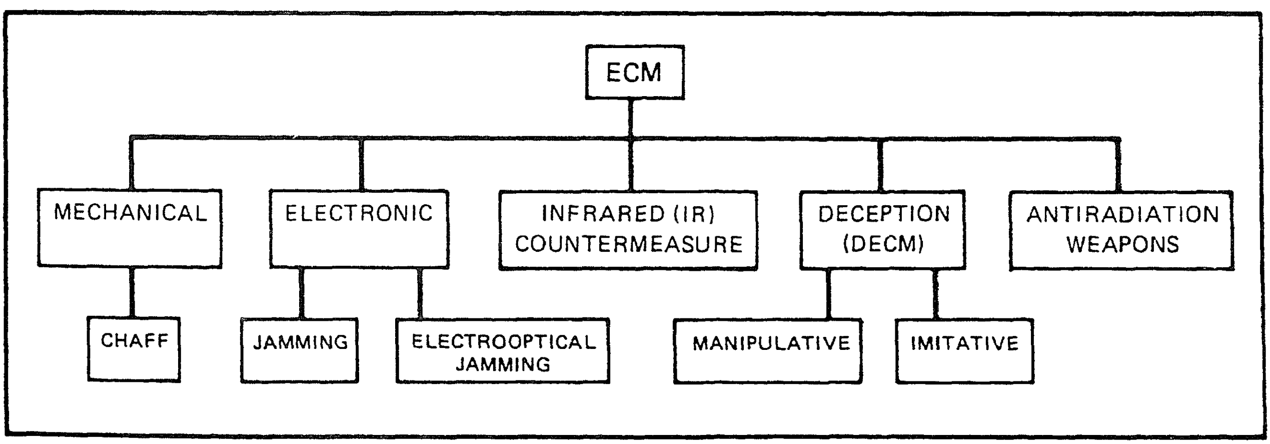

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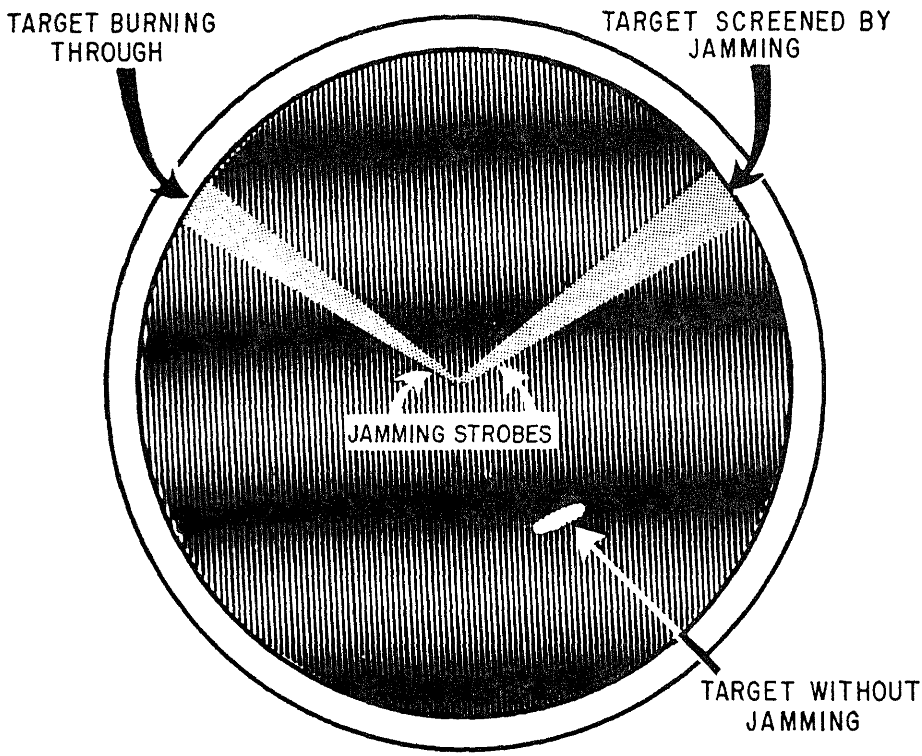
Figure 14-4.—Functional relations of ECM.

essitates a transmitter with a correspondingly
e size, weight and power supply, all of which
t be carried on the aircraft, ship, or vehicle.
ereas a large ship may not be limited by this
irement, an aircraft or small vehicle is limited
he amount of jammer protection it can carry.
Finally, when the radar antenna is pointed
ard the jammer, the radar sees signals at all
ges. The effect on a PPI scope is to create a
d line at the azimuth of the jammer. This line,
ed a strobe, indicates to the operator that a
mer is present and its azimuth; but he does
know the range of the jammer if the jamming
fective. Thus jamming has the bad effect that
n highlight the target's presence and direction
serve to identify it as hostile, but it has the
d effect of denying the radar operator the
ge of the target if sufficient power is used.
re 14-6 illustrates the idea of a strobe. The
strobe shows the consequence of insufficient
ming power. The target return can be seen
ning through.
Major noise jamming techniques—Within the
eral class of jamming, there are three different
niques for generating the noiselike signal to
used. In *spot jamming* all the power output
he jammer is concentrated in a very narrow bandwidth, ideally identical to that of the radar. *Barrage* and *sweep jamming* spread their energy over a bandwidth much wider than that of the radar signal. Thus spot jamming is usually directed against a specific radar and requires a panoramic receiver to match the jamming signal to the radar signal. The other two techniques, however, can be used against any number of radars and only require a receiver to tell them that there is a radar present.

The difference between barrage and sweep jamming lies in the modulation techniques and size of the frequency band covered. *Barrage jamming* often uses an amplitude-modulated signal covering a 10 percent frequency band (bandwidth equal to 10 percent of the center frequency). *Sweep jamming* often uses a frequency-modulated signal, and the frequency is swept back and forth over a very wide bandwidth. Figure 14-7 illustrates these three types of jamming.

It is almost impossible to exactly match a jammer frequency to that of a radiating radar; therefore, it is usually necessary to broaden the bandwidth of the noise so that it is greater than the radar bandwidth. A barrage jammer has a wide bandwidth to cover all radars with



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frequencies in that band; whereas, the spot jammer attempts to match as closely as possible a particular radar frequency.

But this broadening of the jammer bandwidth causes the jammer to require more power than one that is exactly matched because the power that matters for any radar is the power that is accepted by the receiver. This fact is usually accounted for by specifying the spectral power density that a jammer must have to jam a radar. Power density is the power contained in the jammer output spectrum divided by the bandwidth. Figure 14-8 illustrates this idea by showing that a jammer of a given total power is more effective

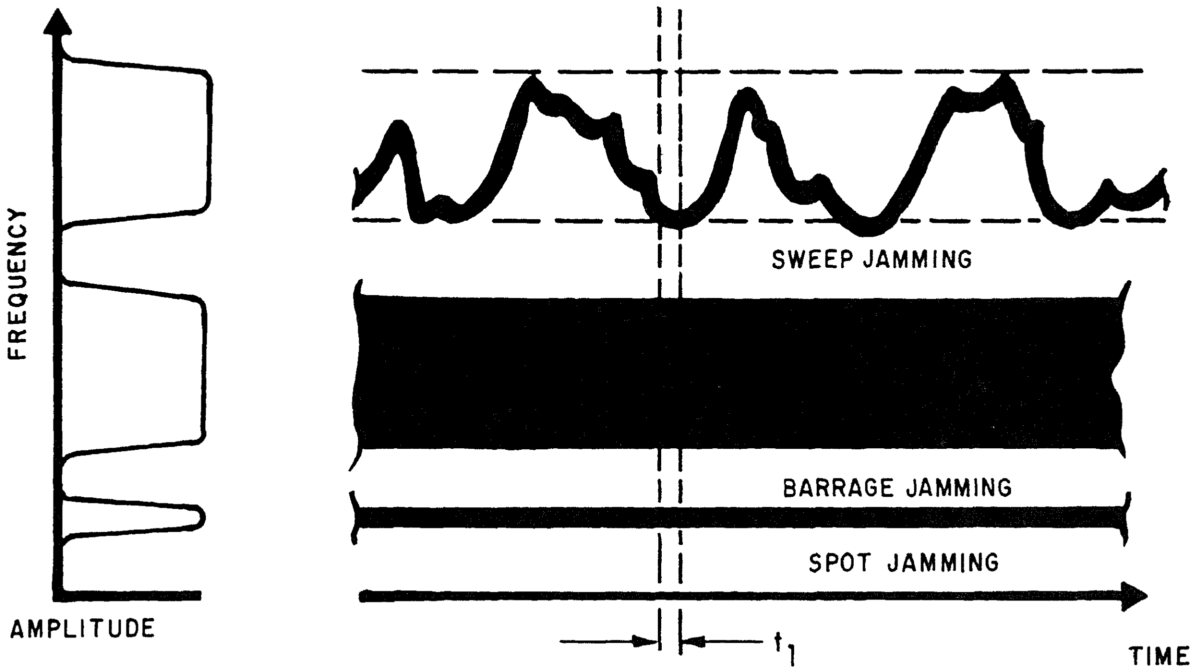

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Figure 14-7.—Spot, barrage, and sweep jamming.

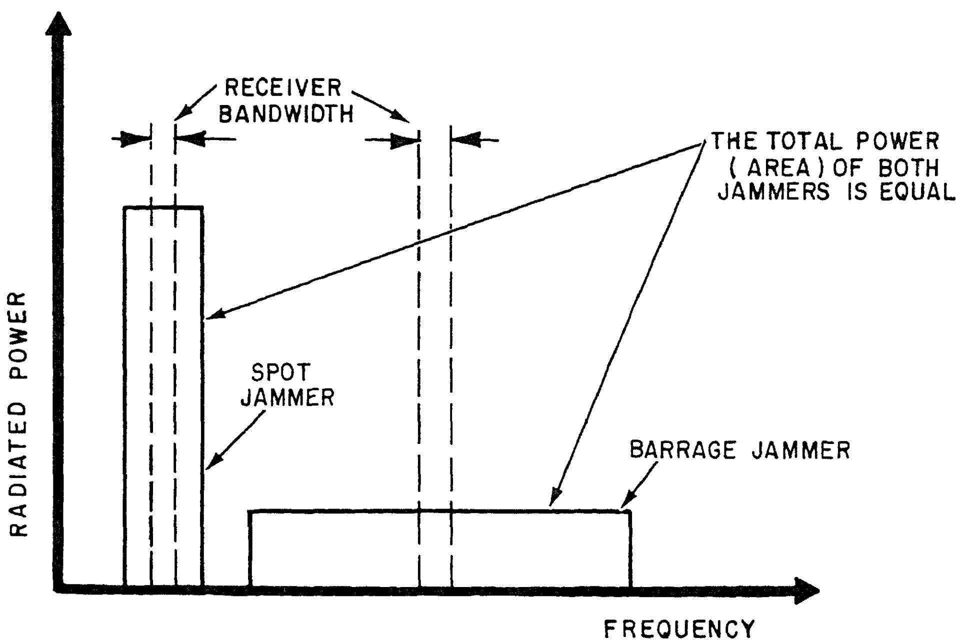

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Figure 14-8.—The effect of bandwidth on jammer spectral power density.

if its bandwidth is decreased. The usual means of specifying jammer power density is in watts per megahertz (w/MHz).

Since aircraft is limited in the total amount of jammer power it can carry, it is advantageous for the air defense network to use as many widely different frequencies for its radars as possible. This concept is usually called *frequency diversity*, and it forces the jamming penetrators to either carry a large number of spot jammers or spread their barrage and sweep jammer power to cover all the radars. Frequency diversity will also eliminate the mutual interference of integrated forces during large operations. The ability of a single radar to change frequency to counter a spot jammer is called *frequency agility*.

DECEPTION JAMMING

The other major type of active ECM is deception jamming. In contrast to noise jamming, deception tries to mimic the radar echo so that the radar will think that it is seeing an echo from another aircraft or ship. For a radar to direct a fire control system correctly, it must accurately measure target range, bearing, and elevation. If either range or bearing are misrepresented without the operator's knowledge, the target's location will be incorrectly established.

Deception jamming is generally accomplished by repeater jammers and transponders. The theory of repeater jammer operation is basically simple. However, actual implementation requires sophisticated circuitry. Basically, the radar signal is received, delayed, amplified, modulated, and retransmitted back to the radar. The transponder differs slightly because it plays back a stored replica of the radar signal after it is triggered by the radar. The transmitted signal is made to resemble the radar signal as closely as possible. Delay may be employed, but amplification is usually not used. The power requirements for a deception repeater are much lower than for a noise jammer since the repeater emits its energy in pulses similar to the radar pulses. Its duty cycle is similar to that of the radar.

Range deception—If a jammer/repeater simply retransmitted the received pulse as soon as it was received, it would reinforce the return echo and would help rather than frustrate the radar. But if the received pulse could be briefly stored and then transmitted a short time interval later, the radar would first receive the weak natural echo-return followed by an identical but stronger pulse. If a jammer transmitted a series of time-displaced pulses identical to the radar pulse, it could produce a series of spurious targets, each at different ranges.

In radars that automatically track targets for fire control purposes, the first step in the process of locking onto a target is for the operator to designate the specific target of interest by assigning it a range tracking gate. Once this is done, the radar's receiver is, in effect, turned off until such time as an echo-return is expected at the approximate range of the designated target, thereby making allowance for the velocity of the target.

This allows the deception repeater to operate in the *range-gate* or track-breaking mode. Initially the repeater simply repeats back the received radar pulse without any delay to allow for the radar's automatic gain control to adjust to the stronger signal, which it assumes to be the designated target.

Then the deception jammer begins to introduce increasing amounts of time delay (fig. 14-9) before retransmitting back the received radar pulse. Thus, the range-gate circuitry in the radar tracks the stronger pulse and gradually "walks off" from the true target range and makes the target appear to be at a greater range than it really is.

Similarly, the target can be made to appear at a closer range by delaying the received radar pulse long enough so that it can be retransmitted back prior to receiving the next radar pulse. Then the deception pulse will arrive at the radar before the real echo pulse producing a false target at a closer range.

This false target range information can cause significant aiming and guidance errors for anti-aircraft guns and for missiles that require command guidance from ground-based radars.

The simplest remedy that the tracking radar can use is to have its operators switch to a manual mode of operation. This remedy is effective because a person watching a radar scope can see the cover pulse move away from the aircraft return and, therefore, can track the aircraft.

Even though manual tracking will largely counter a repeater jammer, manual tracking is never as smooth as automatic tracking. Thus, the weapon miss distance will increase; which, in turn, increases the probability of aircraft survival against nonnuclear defense weapons.

Angle deception—Confusion of a radar system is also accomplished by causing the radar to generate incorrect target-bearing information. In this method, a false signal is provided to the radar when the antenna is pointing in a direction

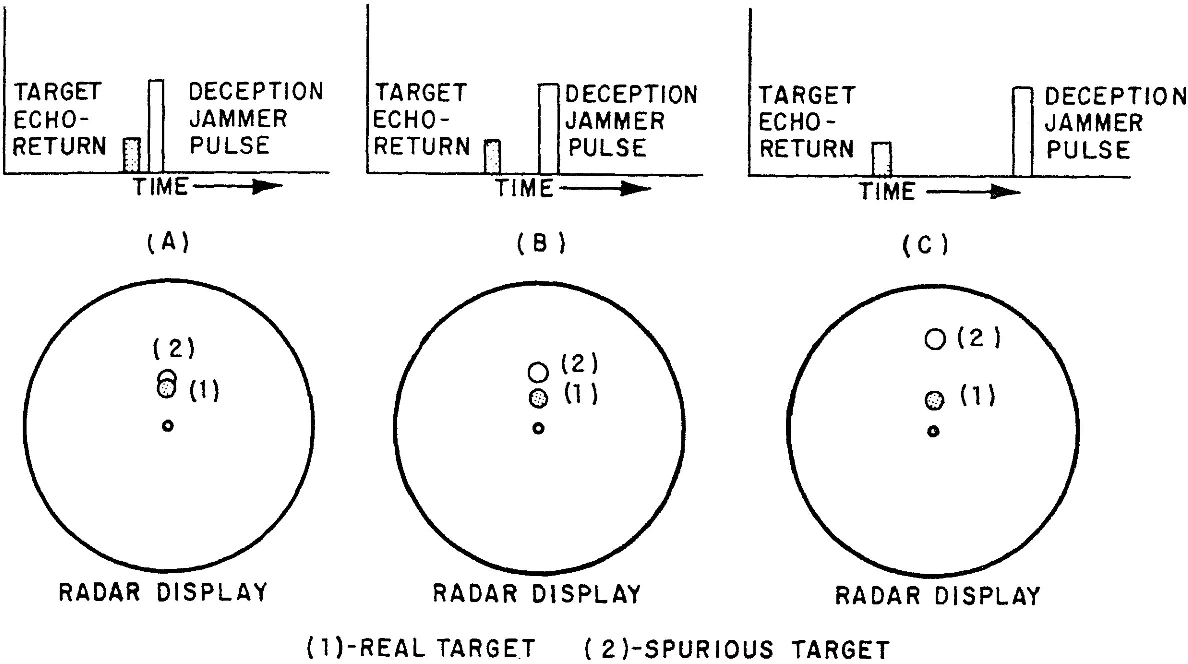

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Figure 14-9.—Range deception jamming as it would appear on an air surveillance radar scope.

other than at the true target. For this method to be successful, the jammer must sense the scan pattern of the radar. Once the scan pattern has been analyzed, it is possible to know when the radar antenna is pointed away from the true target. The deception jammer then generates a strong false echo signal, which the radar now interprets as being at the bearing the antenna is presently pointing. One jamming system that uses this technique is known as an *inverse conical-scan repeater*. It is used to break angle tracking by conical-scan fire control radars. This type repeater is ineffective against COSRO (conical scan on receive only) or monopulse radars.

False-target generation—The false-target generation generates many false targets, which vary about the real target in both range and azimuth. This is accomplished by using both range and azimuth deception techniques simultaneously. The jammer requires very complex circuitry but also needs much less average power than do noise jammers. It is still necessary that the jammer system establish the radar scan or search pattern and PRF and use this information to time the release of the false signals.

Continuous wave Doppler and pulsed Doppler deception—CW doppler and pulsed doppler radars were developed to track high-speed, low-flying aircraft in the presence of ground clutter. The echo-return from these radars that enables the target to be tracked is the Doppler shift because of the target's velocity.

The deception of the CW Doppler requires that the jammer retransmit the received CW signal with a spurious Doppler shift, gradually increasing its magnitude to cause velocity track breaking. This will only cause errors in the fire control solution, but, because of the velocity gate walk off, it can result in loss of target tracking when the jammer is turned off.

Deceptions of the pulsed Doppler radar is much the same. The jammer introduces a similar spurious Doppler shift when it retransmits the received pulses.

Echo/blip enhancer—Another type of deception jammer is the echo or *blip enhancer*. This repeater enlarges the retransmitted pulse to make a small radar target, such as a destroyer, appear as a large carrier apparently at formation center. This may also be done mechanically by using properly designed reflectors, which will make a small target look like a large one.

CHAFF

The primary means of changing the properties of the medium between the radar and the aircraft

on target is to sow something in the atmosphere. This is done by the use of chaff. Dropping chaff from aircraft is a commonly used active countermeasure technique. Chaff consists of small metallic (aluminum) dipoles that are designed to resonate at the radar frequency. Half-wave dipoles make very good radar reflectors. Typical dimensions for half-wave dipoles cut for use against a 10-GHz radar would be 0.6 inches long, 0.01 inches wide, and 0.001 inches thick. Only 0.1 pound is needed to cause an echo equal in size to a large bomber. Thousands of such dipoles are compressed into small packages. When injected into the aircraft slipstream, the chaff packages burst open and the dipoles scatter to form a radar-reflective cloud called a *chaff corridor*.

Each chaff package, dropped independently, can simulate an additional aircraft. A chaff curtain, consisting of thousands of false targets, can be dropped by a small number of aircraft. Such a curtain can so confuse radars that they are unable to locate the real targets within the chaff cloud. Chaff drops so slowly that it normally takes many hours to reach the ground.

When chaff packages are dropped in close sequence, radars viewing the resulting continuous chaff corridor from right angles have difficulty tracking targets within the corridor. If the corridor is viewed nearer to head-on (dispensing aircraft approaching the radar), the radar range gate can be forced to stay on the first return received. Thus the lead aircraft can be tracked and the chaff echoes gated out. When viewing the corridor tail on, the radar can also track the lead aircraft if the range gate is forced to select the last part of the echo. If the dispensing aircraft uses rockets to fire chaff in front of the aircraft, the problem of maintaining tracking is greatly increased.

Since the chaff particles have considerable aerodynamic drag, their forward velocity quickly drops to near zero. Because of its low velocity, chaff can be regarded as an airborne type of *clutter*. Radars such as CW, pulse Doppler, and MTI (moving target indicator) that can reject clutter are not seriously affected by chaff. Thus, they can continue to track a target within a chaff cloud as long as the target has a radial component of velocity.

The use of chaff by surface units has greatly increased in recent years. Chaff dispensed by a rocket or projectile can be used to decoy or break the track of a missile with active radar guidance.

IR/EO COUNTERMEASURES

With the advent of infrared heat-seeking weapons and their increased use, the Department of Defense has been backing an active program for the development of IR countermeasures systems. Several countermeasures have been available for years, such as shielding high IR sources from possible detectors, special non-reflective paints to reduce IR levels radiated, IR decoys, and the tactic of ejecting infrared flares to cause false lock ons of IR weapons. Recently, however, these techniques have received renewed efforts for improvement and refinement. In addition, several new countermeasures systems have been developed, primarily for aircraft.

Among the recent developments are threat warning devices that will alert a pilot that he is under attack by an IR weapon so that he can take evasive maneuvers or use his IR countermeasures. These devices work by use of an IR sensor detecting the boost burn of the missile as it fires. Another new device is an infrared jammer, which will cause IR missiles tracking an aircraft to lose lock. A small detector for the infantryman that will provide a warning when he is actively radiated by an IR detector is another new development as are similar devices for vehicles.

Electrooptical or laser and TV guided weapons are also coming into wide use. Uses of lasers for countermeasures vary from range detection of targets to the use of a laser beam to actually blind the operators of visually aimed weapons. Conversely lasers are being developed to jam enemy range-finding and weapon guidance lasers. Countermeasures against TV guided weapons and TV directed tracking systems are much more difficult to develop, although research is on going in this area.

ELECTRONIC COUNTER-COUNTERMEASURES

Electronic counter-countermeasures (ECCM) preserves effective use of friendly sensor, fire control, communications, navigation, and identification systems despite enemy efforts to degrade them by electronic jamming and/or deception. ECCM employs operator procedures, ECCM features (installed, electromagnetically controlled, and/or dependent systems' circuits), and frequency control to counter enemy ECM. See figure 14-10.

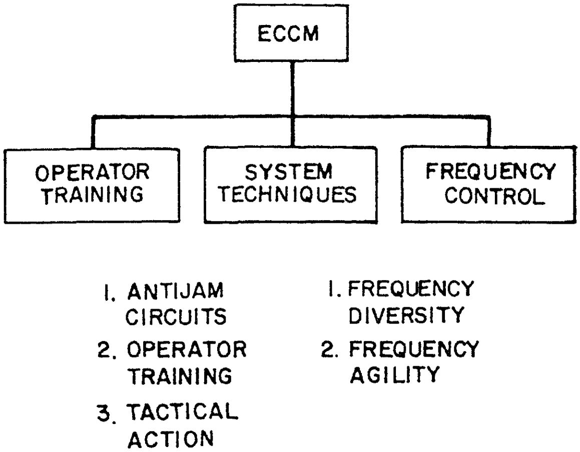

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Figure 14-10.—Functional relationships of electronic counter-countermeasures.

SUMMARY

This chapter has provided the reader with the fundamentals of electronic warfare. Once it is understood that EW is an interaction between friendly and hostile electronic systems, this interaction and the general theory and effectiveness of ECM and ECCM on sensor operation can be studied.

EW has its own specialized equipment to its objectives. Specially designed receivers such characteristics as wide spectrum surveilla wide dynamic range, good unwanted-signal r tion, and good angle-of-arrival measuremen required to gather information. Other equip includes processors, analyzers, displays, transmitters and jammers.

The ECM division of EW involves s method or methods of actively preventin reducing the enemy's use of electromag spectrum. This may be done by jamming, thr deception, or by the use of chaff. Al these methods have varying degrees of suc depending on how and when they are used against which enemy systems they are u This variance in success is what makes E continuous and dynamic interaction.

Finally, ECCM is that division that inv the countering of enemy countermeasures. EC is usually accomplished through some typ design feature built into the sensor (for exam radar). This is done by giving the sensor or r the capability of altering or changing its b parameters such as, frequency, power, PRF, so on. Other methods involve special techni in signal processing and the use of a highly sk operator.

CHAPTER 15

COMMUNICATIONS

As the voice of command, no element is more vital to the success of naval operations than reliable, rapid, and secure communications. Reliability is always paramount. When a conflict arises between security and speed, one or the other must be sacrificed, but never at the expense of reliability.

The first section of this chapter discusses basic communication theory. Succeeding topics include merchant ship communications and equipment, naval communication procedures, and convoy communications.

RADIO WAVE CHARACTERISTICS

Any wire or other conductor carrying alternating current produces electromagnetic fields that move outward into surrounding space. As the current increases and decreases, the electromagnetic field alternately grows and collapses about the wire. When the speed of these alternations is increased above a certain point, the collapsing electromagnetic field does not have time to return to the wire before the next alternation begins. Hence, some of the electromagnetic energy is disengaged from the wire and set free in space. The radiated electromagnetic energy, known as the radio wave, moves in free space at the speed of light, which is approximately 300,000,000 meters (328,000,000 yards—164,000 nautical miles—984,000,000 feet) per second.

Radio waves travel in a series of crests and troughs somewhat like the movement of water waves away from a point of disturbance. Although this analogy is not exact, it serves to compare the movement of radio waves with a well-known physical action.

A radio wave has four basic characteristics: amplitude, cycle, frequency, and wavelength. Amplitude is a measure of the wave's energy level; it is the maximum instantaneous value of the alternating current, measured in either a positive or a negative direction from the average level.

A cycle is one complete reversal of an alternating current, starting at zero and going through a positive peak, then a negative peak, and back to zero. The number of cycles occurring in 1 second is the wave's frequency. The standard measurement of radiofrequency (RF) is the hertz, with 1 cycle per second being equal to 1 hertz (Hz). Most radiofrequencies are expressed in kilohertz (kHz) or in megahertz (MHz).

A wavelength is the space occupied by 1 cycle; it may vary from several miles to a fraction of an inch. Wavelengths usually are measured in meters, but on occasion they are expressed in feet. Since a radio wave travels at a constant speed, wavelength (symbol λ) may be determined by dividing wave velocity (V) by wave frequency (F).

Formulas for finding wavelengths are as follows:

1. $\dfrac{300{,}000}{F\ (\mathrm{kHz})} = \lambda$ in meters

2. $\dfrac{300}{F\ (\mathrm{MHz})} = \lambda$ in meters

3. $\dfrac{984}{F\ (\mathrm{MHz})} = \lambda$ in feet

FREQUENCY SPECTRUM

Electronic equipment operates on frequencies ranging from 10,000 hertz to several thousand megahertz. By international agreement these

frequencies are divided into eight bands as shown in table 15-1.

Because the VLF and LF bands require great power and long antennas for efficient communications, the Navy normally uses these bands only for shore installations.

Several bands have areas that are not available for military usage. For example, the commercial radio broadcast band of 530 kHz to 1600 kHz is in the FM band. Popular citizens band frequency of 27 MHz is in the HF band. FM and television broadcasting frequencies are in the VHF band. FM broadcasts are between 88 and 108 MHz. Television channels 2 through 6 use frequencies of 54 to 88 MHz, and channels 7 through 13 use frequencies of 174 to 216 MHz.

The upper portion of the VHF band and the lower portion of the UHF (225 to 400 MHz) are used extensively by the Navy for its radio communications. The frequencies above 400 MHz normally are used for radar, special equipment, and other purposes, such as the television UHF channels (470 to 890 MHz).

WAVE PROPAGATION

When a RF current flows through a transmitting antenna, radio waves are radiated from the antenna. Part of each wave moves outward in contact with the ground to form a groundwave, and the rest of the wave moves outward and upward to form a skywave. The ground and sky portions of the radio wave are responsible for two different methods of carrying signals from transmitter to receiver.

Keeping technical discussions to a minimum, this section describes antennas, radio wave

Table 15-1.—Frequency Bands

ABBREVIATION	FREQUENCY BAND	FREQUENCY RANGE
ELF	Extremely low frequency	below 300 Hz
ILF	Infra low frequency	300-3000 Hz
VLF	Very low frequency	3-30 kHz
LF	Low frequency	30-300 kHz
MF	Medium frequency	300-3000 kHz
HF	High frequency	3000-30,000 kHz
VHF	Very high frequency	30-3000 MHz
UHF	Ultrahigh frequency	300-3000 MHz
SHF	Superhigh frequency	3000-30,000 MHz
EHF	Extremely high frequency	30-300 GHz

propagation, and transmission characteristics of the frequency bands.

ANTENNA CHARACTERISTICS

In its simplest form an antenna may be merely a length of wire. For communication work, however, other considerations make the design of an antenna system a more complex problem. The height of the radiator above ground, the conductivity of the ground plane, the frequencies to be covered, and where and how the antenna is mounted aboard ship all affect the antenna's radiated field strength.

The strength of a radio wave radiated by an antenna depends on the length of the antenna and the amount of current flowing in it. Because the antenna is a circuit element having inductance, capacitance, and resistance, the largest current is obtained when the inductive and capacitive reactances (opposition to the flow of alternating current) are tuned out; that is, when the antenna circuit is made resonant at the frequency being transmitted.

The shortest length of wire that will be resonant at any particular frequency is one just long enough to permit an electric charge to travel from one end of the wire to the other end and back again in the time of 1 cycle. The distance traveled by the charge is 1 wavelength. Because the charge must travel the length of the wire twice, the length of wire needed to have the charge travel 1 wavelength in 1 cycle is half a wavelength. Thus, the half-wave antenna, or dipole, is the shortest resonant length and is used as the basis for all antenna theory.

An antenna can be made resonant by two methods: (1) by adjusting frequency to suit a given antenna length; or, usually the more practical, (2) by adjusting the length of the antenna wire to suit a given frequency. It is, of course, impractical to lengthen or shorten an antenna physically every time the transmitter is changed to a new frequency. The antenna length may, however, be changed electrically. This change is accomplished by a process known as tuning, or loading, the antenna.

The polarization of a wave is determined by the direction of the electric lines of force (E field). If the field is vertical, the polarization is vertical, and so on. Since the E field is parallel to the wire or arms of a simple antenna, an antenna that is vertical with respect to the Earth radiates a vertically polarized wave, while a horizontal antenna radiates a horizontally polarized wave (fig. 15-1). For best reception the receivi antenna should lie in the same plane as t transmitting antenna.

Although RF energy travels at the speed light through free space, it is retarded wh moving across an antenna because of the antenna resistance to current flow and other factors. T phenomenon of retardation is referred to as e effect because the ends of the antenna are, effect, made further apart electrically than th are physically. Consequently, the physical leng of an antenna should be about 5 percent short than the corresponding half-wavelength.

PROPAGATION EFFECTS

One of the many problems encountered communications is the changeable propagati conditions of the radio transmission path. Rad waves can be reflected, refracted, and diffract in a manner similar to light and heat waves. a result it is usually necessary to change freque cies on HF trunks during any operating day overcome the limitations imposed by varyi propagation conditions.

Reflection

Radio and light waves alike travel in straig lines, but they may be reflected from any sharp defined substances or objects of suitab characteristics and dimensions that are encounter in the medium of travel. The wave is not reflect from a single point on the reflector but rath from an area of its surface. The size of the ar

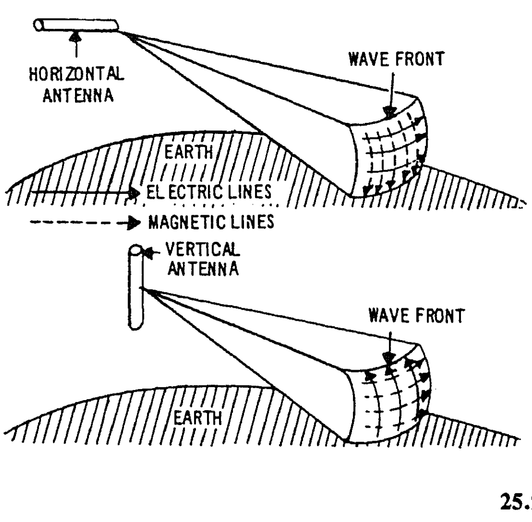

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Figure 15-1.—Wave polarization.

required for reflection depends on the wavelength and angle of incidence. When a wave is reflected from a plane (flat) surface, a phase shift occurs. The amount of the phase shift depends on the polarization of the wave and the angle of incidence.

Refraction

As in the case of light, a radio wave is bent when it moves from one medium into another in which the velocity of propagation is different from that of the first medium. The bending, which is called refraction, is always toward that medium in which the velocity is the least. If a wavefront is traveling obliquely from the Earth and encounters a medium with a greater velocity of propagation, the part of the wavefront that first enters the new medium travels faster than parts of the wavefront that enter later. The difference in the rate of travel tends to swing the wavefront around or to refract it in such a manner that it is directed back to Earth.

Diffraction

A radio wave is also bent when it passes the edge of an object. The bending, called diffraction, results in a change of direction of part of the energy from the line-of-sight path. This change makes it possible to receive energy at some distance below the summit of an obstruction or around its edges (fig. 15-2). In certain cases, by using high power and very low frequencies, the waves can be made to encircle the Earth by diffraction.

Trapping

Normally the warmest air is near the Earth's surface, but when a temperature inversion occurs, the index of refraction is different for the air within the inversion than for the air outside the inversion. These differences cause the formation of a channel or duct that acts as a waveguide within which transmitted signals are trapped. The result is that the signals are piped many miles beyond the assumed normal range.

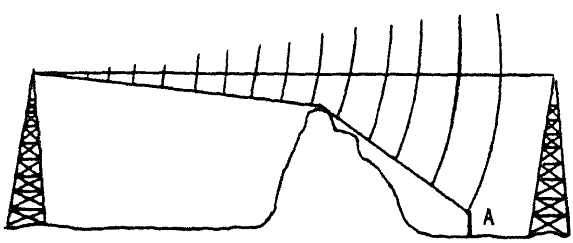

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Figure 15-2.—Diffraction of transmitted energy.

At times these ducts are in contact with the water and may extend a few hundred feet into the air. At other times the duct starts at an elevation of 500 feet or more and extends an additional 500 to 1,000 feet upwards.

A necessary feature of duct transmission is that both the transmitting and receiving antennas must be inside the duct. A transmitting antenna above a surface duct will not operate into the duct. Hence, a receiving antenna below a duct receives no signals from an aircraft flying in or above a duct, even though line-of-sight conditions prevail.

The peculiar structure of the atmosphere that produces trapping occurs fairly often in many parts of the world. Several types of meteorological conditions can produce the temperature and humidity gradients necessary for trapping to take place.

SURFACE DUCT.—Warm continental air blowing over a cooler sea leads to formation of a duct by causing a temperature inversion as well as by evaporation of water from the cooler sea into the lower levels of the warm, dry air. The base of such a duct is usually the sea surface with the trapping region extending several hundred feet upward.

Over the open ocean, a surface duct may be formed by cool air blowing over a warmer sea. No temperature inversion is associated with this phenomenon, and the entire effect is caused, apparently, by evaporation of water into the lower levels of the atmosphere. Ducts of this sort are often created by trade winds that have blown for a long distance over the open sea.

ELEVATED DUCT.—An elevated duct may form in an area of high barometric pressure because of the sinking and lateral spreading of the air, termed subsidence. When the air is warm and dry and subsidence takes place over the sea, water is evaporated into the air, forming a moisture gradient that leads to formation of a duct. Such ducts always are formed above the sea, with the base of the trapping layer ranging in elevation from a few thousand to 20,000 feet. Subsidence trapping nearly always can be found in the tropics.

Other meteorological conditions that may produce trapping are the cooling of land at night by radiation and the mixing of two masses of air, as at a warm or cold front. Ducts formed by these effects are likely to be of such limited extent that they are unable to modify propagation by any appreciable amount.

IONOSPHERE

Knowledge of the general composition of the Earth's atmosphere is important to understand its effects on the propagation of radio waves. The atmosphere is not uniform, changing with changes in height or geographical location and with changes in time (day, night, season, year). There are three more or less distinctive layers of the atmosphere: troposphere, stratosphere, and ionosphere.

The troposphere extends to a height of about 6 miles. Temperatures in this region vary appreciably with altitude and, along with humidity and pressure, cause varying degrees of diffraction of the groundwave.

The stratosphere extends from the top of the troposphere to a height of about 30 miles. Temperatures in this region remain fairly constant with the result that the stratosphere has little effect on radio waves.

The ionosphere extends from about 30 miles to 250 miles above the Earth. As its name implies, the ionosphere differs from the other layers because it contains a much higher number of positive and negative ions. The negative ions are believed to be atoms whose energy levels have been raised to a high level by solar bombardment of ultraviolet and particle radiations. The rotation of the Earth on its axis, the annual course of the Earth around the Sun, and the development of sunspots all affect the number of ions present in the ionosphere, and these in turn affect the quality and distance of electronic transmissions.

Different densities of ionization at different heights make the ionosphere appear to have layers. Actually there is no sharp dividing line between layers, but for the purpose of discussion a sharp demarcation is indicated. In order of increasing heights and intensities, the layers of the ionopshere are identified as the D, E, F1, and F2 layers. The relative distribution of the layers is indicated in figure 15-3. As can be seen all four layers are present only during the daytime, when the Sun is directed toward that portion of the atmosphere. During the night, the F1 and F2 layers seem to merge into a single F layer, and

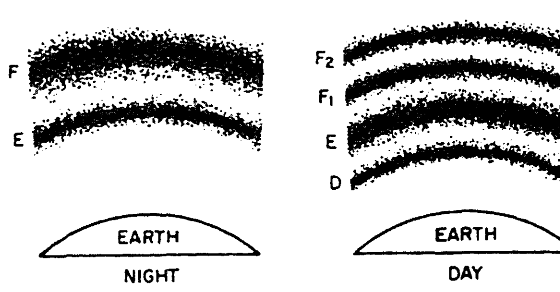


Figure 15-3.—Layers of the ionosphere.

the D and E layers fade out or at least becor noticeably weaker. This is only a general concep however. The actual number of layers, th heights, and their relative intensities of ionizati apparently vary constantly, even from hour hour.

The ionized atmosphere at an approxima altitude of between 30 and 50 miles is designat the D layer. Its ionization is low and has lit effect on the propagation of radio waves exce for the absorption of energy from the radio wav as they pass through it.

At heights of between 50 and about 100 mil lies the band of atmosphere containing the layer. The ionization of the E layer follows t sun's altitude variations closely, reaching maximum at about noon local time. During t middle of the day, ionization of the E layer m be sufficiently intense to refract frequencies to 20 MHz. Thus the E layer is of great impo tance to daylight transmissions for distances to 1,500 miles. Ionization fades to such a we level during the night as to be practically usele as an aid to high-frequency communication.

The F layer extends approximately from t 100-mile level to the upper limits of t ionosphere. At night, only one F layer is prese but during the day, especially when the sun high, this layer often separates into two parts, and F2. The F2 layer is the most highly ioniz of all the layers, and it is the most useful for lo range communication. The degree of ionizati of this layer exhibits an appreciable day-to-d variation in comparison with that of the oth layers. The intensity of ionization reach maximum in the afternoon and gradually decrea throughout the night. The rise of ion density very rapid in the morining, and the low reco bination rate permits the high ion intensity persist.

Ionospheric Variations

Because the existence of the ionosphere depends on radiations from the sun, it is obvious that the movement of Earth about the sun, or changes in the sun's activity that might cause an increase or decrease in the amount of its radiation, will result in variations of the ionosphere. These variations include (1) those which are more or less regular in their nature and therefore can be predicted in advance, and (2) irregular variations resulting from abnormal behavior of the sun. The regular variations may be divided into four classes: daily, seasonal, 11-year, and 27-day variations.

DAILY.—Daily ionospheric variations were discussed in the description of the F layer. The increased ionization during the day is responsible for important changes in skywave transmission. For one thing, it causes the skywave to be returned to Earth closer to the point of transmission. Another consideration is that the extra ionization increases the absorption of energy from the wave, resulting in greater wave attenuation.

It is necessary that higher frequencies be employed during the daytime than at night to compensate for daily variations. The main reason for this is that the greater daytime ionization of the F2 layer refracts waves of higher frequency than the same layer does at night. Further, the higher the frequency employed, the less attenuation occurs as the RF energy passes through the D region.

SEASONAL.—As the apparent position of the sun moves from one hemisphere to the other with changes in season, the maximum ionization in the D, E, and F1 layers shifts accordingly, each being greater during the summer. The F2 layer, however, does not follow this pattern in seasonal shift. In most localities, the F2 ionization is greatest in winter and least in summer, the reverse of what might be expected. The separation of the F1 and F2 layers is not so well defined in summer, because the height of the F2 layer is less during that season.

11-YEAR SUNSPOT CYCLE.—Sunspot activity varies according to a 11-year cycle. Sunspots affect the amount of X-ray and ultraviolet radiation, and hence they affect the ionization of the atmosphere. During periods of high sunspot activity, ionization of the various layers is greater than usual, resulting in higher critical frequencies for the E, F1, and F2 layers, and higher absorption in the D region. This permits the use of higher frequencies for communication over long distances at times of greatest sunspot activity. The increased absorption in the D region, which has the greatest effect on the lower frequencies, requires that higher frequencies be used, but the overall effect is an improvement in propagation conditions during years of maximum sunsport activity.

27-DAY SUNSPOT CYCLE.—The 27-day sunspot variation is caused by the rotation of the sun on its axis. As the number of sunspots changes from day to day with rotation of the sun or the formation of new spots or the disappearance of old ones, absorption by the D region also changes. Similar changes observed in the E layer cover a wide geographic range. Fluctuations in the F2 layer are greater than for any other layer, but generally are not of a worldwide character.

IRREGULAR VARIATIONS.—A number of transient and unpredictable events bear on skywave propagation. Some of the more prevalent are sporadic E ionizations, sudden ionospheric disturbances (SID) and magnetic storms, and scattered reflections.

Sporadic E ionizations are erratic patches of ionized cloud that appear in the E layer. These ionized clouds vary greatly in density. At times, they reflect so much of the radiated wave that reflections from the other layers of the ionosphere are blanked out completely. At other times, the sporadic E may be so thin that reflections from the upper layers can be received easily through it. The sporadic E layer may occur during the day or night; its occurrence is frequent, although more prevalent in the tropics than in higher latitudes.

The most startling of all the irregularities of radio wave transmission is the sudden type of ionospheric disturbance causing a shortwave fadeout (SWF). This disturbance, caused by a solar eruption (flare), comes without warning and may last for several hours. All stations on the sunlit side of the Earth are affected. At the onset of the disturbance, receiving operators are inclined to believe that their radio sets suddenly have gone dead. The solar eruption causes a sudden increase

in the ionization of the D region. This is accompanied frequently by disturbances in the Earth's magnetic field 24 to 48 hours later.

An ionospheric magnetic storm may last from several hours to several days and usually extends over the entire Earth. High-frequency skywave transmission is subject to severe fading, and wave propagation is erratic.

GROUNDWAVE

The groundwave is that part of the total radiated energy that is propagated at a low angle from the transmitting antenna and travels close to the Earth. The groundwave includes components traveling in actual contact with the Earth as well as components that travel directly from the transmitting antenna to the receiving antenna when the two antennas are high enough from the ground so that they can "see" each other. For purposes of discussion, groundwaves are assumed not to be propagated via the ionosphere. The two components of a groundwave are the surface wave and the space wave.

Surface Wave

A surface wave is that part of the groundwave that is affected chiefly by the conductivity of the Earth and is able to follow the curvature of the Earth's surface. The surface wave is not confined to the Earth's surface, however. It extends to considerable heights, diminishing in strength with increased height. Because part of its energy is absorbed by the ground, intensity of the surface wave is attenuated in its travel. The amount of attenuation depends on the relative conductivity of the Earth's surface.

The terms "good soil" and "bad soil" are used to describe the degree of absorption. Good soil has high conductivity and dielectric constant, such as clay, marshland, and saltwater. Poor soil has a high resistance with a resultant increased attenutation of the groundwave. Examples of poor soil are rock, gravel, and sand. The worst types of soil are found in heavily populated metropolitan and industrial centers and in jungle areas with thick, damp foliage.

Space Wave

While the characteristics of the surface wa
serve to explain propagation of signals in the V
to HF frequency ranges, they do not seem to ap
to reception of higher frequencies within a
slightly beyond the radio horizon. Such sign
are considered to be propagated via the spa
wave. Space waves are composed of two co
ponents; direct waves and ground reflected wav
The direct waves travel direct line-of-sight pat
while the ground reflected waves are reflect
from the Earth in a similar manner as skywav
are refracted from the ionosphere. Although spa
waves suffer little ground attenuation, they a
susceptible to fading.

A direct wave travels close to but not
contact with the Earth, directly from transmitti
to receiving antenna. Consequently, the receivi
antenna must be situated within the radio horiz
of the transmitting antenna. This distance can
extended by increasing the height of either t
transmitting or receiving antenna, effective
extending the horizon. Because radio waves a
refracted or bent slightly even when propagat
through the troposphere, well below t
ionosphere, the radio horizon is actually abo
four-thirds times the line-of-sight horizon.

A ground reflected wave, as its name indicat
is that part of the space wave that reaches t
receiving antenna after being reflected from t
surface. Upon reflection the wave undergoes
phase shift and partial absorption (because
refraction). There also is a longer transit tim
Consequently, the received signal is a combi
tion of the direct and reflected waves that m
add to or cancel each other, depending on t
amount of phase difference. A 180° pha
difference can result in complete fading of t
signal.

SKYWAVE

The behavior of the skywave is quite differe
from that of the groundwave. Some of the ener
radiated is refracted by the ionosphere and
bounced or reflected back toward the Earth.
a receiver is located in the area where the retu
ing wave strikes, it is possible to detect the sign
clearly even though the receiver is located seve
hundred miles beyond the range of the grou
wave. The ability of the ionosphere to return

radio wave to Earth depends upon the angle at which the skywave strikes the ionosphere, the frequency of the transmission, and the ion density.

In figure 15-4 the signal is assumed to be composed of three rays. The angle at which ray 1 strikes the ionosphere is too nearly vertical for the ray to be returned to Earth. The ray is bent out of line, but it passes through the ionosphere and is lost. The angle made by ray 2 is called the critical angle for that frequency. Any ray that leaves the antenna at an angle greater than the critical angle will penetrate the ionosphere. Ray 3 strikes the ionosphere at the smallest angle that will be reflected and still return to Earth. At any smaller angle, the ray will be refracted but will miss the Earth completely. As the frequency decreases, the critical angle increases.

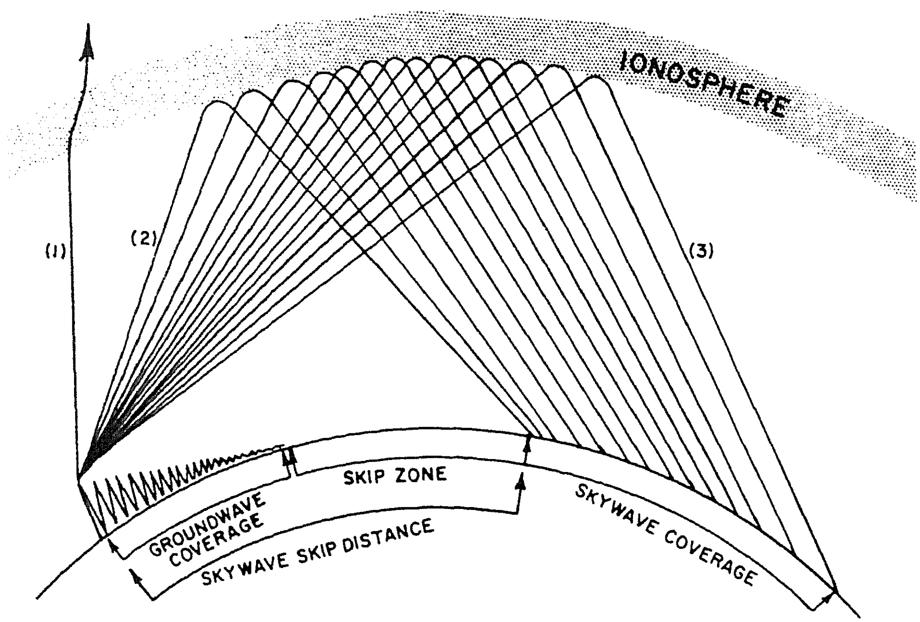
High-frequency fields can be projected straight upward and will be returned to Earth at certain frequencies. The highest frequency that can be sent directly upward and still be returned to the Earth is the critical frequency. At sufficiently high frequencies, the wave will not be returned to the Earth, regardless of the angle at which the ray strikes the ionosphere.

In figure 15-4, note the relationship between skip zone, skip distance, and the groundwave. The skip zone depends on the range of the groundwave; it disappears entirely if the range of the groundwave equals or exceeds the skip distance. The skip distance, which depends on the frequency and the degree of ionization present, is the distance from the transmitter to the nearest point at which reflected waves return to Earth. If the skywave returns to Earth at a point where the groundwave and skywave are of nearly equal intensity, the skywave alternately reinforces and cancels the groundwire, causing severe fading of the signal. This is caused by the phase difference between the two waves resulting from the longer path traveled by the skywave.

Frequently a skywave has sufficient energy to be reflected more than one time. It then is known as a double-hop or multiple-hop transmission, and results in the valuable "skip" needed for long-range communications.

FREQUENCY SPECTRUM USAGE

The allocated uses of the various parts of the radiofrequency spectrum are determined largely by propagation characteristics and by the type of installation. The several factors which determine propagation characteristics are intricately interrelated and vary continuously throughout the usable frequency spectrum; hence, no rigid division can be made within the spectrum in discussing the behavior of radio transmissions.



31.17

Figure 15-4.—Relationship between skip zone, skip distance, and groundwaves.

Low and Very Low Frequencies (Less Than 300 kHz)

Frequencies in this range are propagated principally by ground and surface waves and do not depend upon the reflective properties of the ionosphere for their operation. The quality of transmission is exceptionally stable, as it is not adversely affected by daily, seasonal, or solar activity variations, although some circuit outage because of noise may be experienced. These frequencies are of great value in polar regions, where communications in higher bands may suffer seriously from disturbed ionospheric and magnetic conditions. The use of high powered transmitters gives reliable coverage over long distance or large areas, making this portion of the spectrum well adapted for long-range communications. Because of the large size of receiver and transmitter components, especially antennas, these frequencies are better suited for fixed installations than for portable or mobile equipment.

Medium Frequencies (300 to 3000 kHz)

Frequencies in this range possess some of both the groundwave transmission characteristics of the lower frequencies and skywave (ionospheric) properties of the higher frequencies. The middle portion of this band (535 to 1605 kHz) has been allocated on a worldwide basis for the broadcasting service. Frequencies between 300 and 500 kHz are used primarily for medium range mobile communciations and navigational services. Frequencies between 1605 and 3000 kHz are used primarily for short and medium range fixed and mobile communications.

High Frequencies (3 to 30 MHz)

Frequencies in this band are propagated almost entirely by reflection in the various ionized layers in the upper atmosphere. Proper choice of frequency and transmitter power permits communication over great distances; however, due allowance must be given for variations which occur in the ionosphere, so that a successful operating frequency may be selected on the basis of geographical location of the circuit, time of day, season of the year, and portion of the 11-year sunspot cycle. Transmissions in this band are adversely affected when the circuit passes through the auroral zones in the vicinity of the North and South Poles, and during periods of disturbed ionospheric or magnetic conditions. Because of their long-range transmission capabilities, frequencies in this band are much sought after, and allocations and assignments must be made in the most economical manner possible to permit satisfaction of essential requirements. This band is used by government and nongovernment fixed, mobile, and portable operations.

VHF Band (30 to 300 MHz)

As a rule, ionospheric propagation is negligible in the VHF band and cannot be relied upon for propagation to great distances. However, irregular ionospheric refractions are possible and can cause a signal in the lower part of the band to be propagated several hundred miles by the ionosphere.

The most common path of propagation used at VHF frequencies is through the troposphere and along the surface of the Earth. Since the density of the Earth's atmosphere normally decreases with altitude, radio waves are propagated by refraction along a curved path to a distance approximating four-thirds of the Earth's true horizon. In this frequency range, the radio horizon is governed not only by refraction but by diffraction as well.

Frequencies at the lower end of this band are capable of overcoming the shielding effects of hills and structures to some degree. However, as the frequency is increased, the shielding effect becomes more pronounced.

Atmospheric noise at these frequencies is fairly low and decreases with increasing frequency. The more important sources of noise in this range are man-made, such as ignition system, diathermy machines, and X-ray equipment. In this range, receiver noise and cosmic noise also begin to become prevalent.

This band of frequencies is put to a wide variety of uses, including fixed and mobile communications, radio location devices, and navigation aids.

UHF Band (300 to 3000 MHz)

Almost all the energy transmitted from point to point in the UHF band is propagated through the Earth's troposphere along a curved path. The refracted path may again be assumed to be a straight line path extending to distances of four-thirds the true horizon. However, the transmission range may be extended several hundred miles further by means of tropospheric scatter propagation.

Ground reflections are still present at ultrahigh frequencies and can cause multipath fading because of destructive interference, although such reflections become less important at the higher frequencies of this band. However, a second type of multipath fading can occur when parts of the wave are refracted through higher layers of the atmosphere and become bent sufficiently to return and combine with the wave received over a lower and more direct path.

Atmospheric and man-made noise in this frequency band is extremely low, with the exception of ignition pulses, which can become serious at times. Receiver noise is somewhat greater at these frequencies and increases with increasing frequency, thus calling for special circuit design in the RF input section of the receiver.

Lower SHF Band (3 to 13 GHz)

At the frequencies of the lower SHF band, transmission is generally limited to line-of-sight distances based on four-thirds the true horizon. Very little wave reflection will radiate from the Earth at these frequencies. Instead, the Earth will act as if it were made up of an infinite number of small mirrors, each reflecting the incident wave in a different direction. This phenomenon is sometimes called diffuse reflection. In addition, incident radiation will also be absorbed by the Earth's vegetation. The amount of reflected energy from the Earth's surface is small; consequently, very little wave interference will occur from that source. However, multipath fading and refraction by several propagation paths through the atmosphere is important throughout the entire band. There is also a tendency for buildings and other man-made objects to cast sharp shadows at these frequencies. If the surface of such objects is smooth, they will reflect the waves in a new direction.

Rain scattering and absorption can cause a serious loss of radiated power at the higher end of this frequency range. If the drop size is comparable to the wavelength of the propagated wave, a very substantial portion of the transmitted energy will be reradiated from the raindrop in a wide range of directions. This phenomenon, known as scattering, has an attenuating effect on radio waves, an effect somewhat like that of diffuse Earth reflections. However, not all the energy incident upon a raindrop is reradiated; instead, it is virtually trapped or absorbed and converted into heat. If the drop size is comparatively small in relation to the wavelength, such losses are dependent only upon the volume of water in suspension and therefore are generally negligible.

The use of sharply beamed waves to overcome the losses due to atmospheric attenuation in this band conserves enough power to enable a few watts of directed power to be as effective at a distant receiver as many kilowatts of undirected power.

Table 15-2 summarizes the propagation characteristics and uses of the various frequency bands.

METHODS OF TRANSMISSION

Of the several methods of radio communications available, those used most commonly by the Navy are radiotelegraphy, radiotelephony, radioteletype, and radiofacsimile.

Radiotelegraph

Radiotelegraph (continuous wave or CW telegraphy) is a system for transmitting signals by using a wave of radiofrequency energy. The radio operator separates the continuously transmitted wave into dots and dashes, based on the Morse code, by opening and closing a telegraphic handkey. This system is rarely used in today's Navy. The Navy now relies on electronic modulation techniques. However, manual telegraphy is still used when communicating with other organizations, such as the merchant fleet, Coast Guard, and NATO units. Despite the development of more rapid electronic communications, manual CW telegraphy still is a reliable communicating system used by the Navy.

Teletypewriter

Teletypewriter (TTY) signals may be transmitted by either landline (wire), submarine cable, or radio. The landline and the submarine cable systems are used widely both by the military services and by commercial communication facilities. Radio teletypewriter (RATT) is extensively used for high-speed record communications with mobile forces and to provide a backup system for landline or submarine systems.

The Defense Communication Satellite System also has the the capability to handle RATT. It is also programmed to replace most shore-to-ship RATT communication links.

Table 15-2.—Frequency Spectrum Usage

	BAND	PROPAGATION CHARACTERISTICS	TYPICAL USES
Below 3 kHz	ELF	Same as LF	Very long-distance point-to-point.
3-30 kHz	VLF	Same as LF, except attenuation equally low day or night; very reliable.	Very long-distance point-to-point and especially fleet BCST communications.
30-300 kHz	LF	Primarily ground waves; low attenuation; reliable; day-time absorption of sky-waves greater than at night.	Long-distance point-to-point comm, marine, Navaids.
300-3000 kHz	MF	Ground waves but some ionospheric sky-waves; attenuation of sky waves low at night and high in daytime; subject to ground-sky wave interference for distances less than 500 n.m. especially at night.	Broadcasting, marine comm, Navaids, harbor telephone.
3-30 MHz	HF	Transmission over great distances depending solely on ionosphere; varies greatly with time of day, season, frequency and portion of solar sunspot activity cycle; subject to ground-sky wave interference at short distances.	Moderate and long distance communications of all types.
30-300 MHz	VHF	Sporadic ionospheric effects occur during high portion solar cycle.	Short-distance comm, television, FM broadcasting, Navaids.
300-3000 MHz	UHF	Same as EHF	Short-distance comm, radar, television, aero-Navaids.
3-30 GHz	SHF	Same as EHF	Short-distance comm, radar, relay systems, Navaids.
30-40 GHz	EHF	Substantially straightline propagation analogous to that of light waves; unaffected by ionosphere.	Radar, radio-relay, Navaids, voice modulated light.

The majority of Navy record communications for mobile forces is handled via RATT circuits. For example, the Fleet Broadcast System handles the vast majority of RATT message traffic destined for afloat units. Message traffic that is originated at sea for ashore units normally will be transmitted on either a full-time ship-to-shore circuit or dedicated on-call frequencies that are guarded full time by a naval communication station. Except for special applications RATT

circuits operate at 100 words per minute, which enables the system to handle extremely large volumes of message traffic with a high degree of reliability.

Radiotelephone

The radiotelephone (R/T) is considered one of the most useful military communication devices. Because of its directness, convenience, and ease of operation, voice radio is used almost exclusively between ships and between ships and aircraft for short-range (20 to 25 miles) tactical communications. There is little or no delay while a message is prepared for transmission, and acknowledgements can be returned instantly. The R/T equipment usually is operated on frequencies that are high enough to have line-of-sight characteristics; that is, the radio waves travel in straight lines thereby limiting the range to the visual horizon, and this characteristic provides a degree of communication security. Because most radiotelephone transmissions are sent in plain language, strict circuit discipline is mandatory.

Facsimile

Facsimile (FAX) is the process used to transmit photographs, charts, and other graphic information electronically. The image to be transmitted is scanned by a photoelectric cell, and electrical variations in the cell output (corresponding to the light and dark areas being scanned) are transmitted to the receiver. At the receiver, the signal operates a recorder that reproduces the picture. The FAX signals may be transmitted by either landline or radio.

PEACETIME MERCHANT SHIP COMMUNICATIONS

The Navy's communication network is vast, complicated, and expensive. No privately owned shipping company could afford to support such a network or, for that matter, would have need for such extensive facilities. Yet, the need for rapid communications between merchant ships and their owners is apparent. The merchant companies may contract with radio service companies in the same way that corporations and individuals ashore do to obtain access to rapid communication facilities offered by commercial telephone and telegraph companies.

All of these companies have shore stations located in various parts of the world. These stations are augmented by facilities of other radio companies through contract arrangements that effectively give each U.S. radio company worldwide coverage. Once a message from a ship is received ashore, it is retransmitted through the radios and landlines of the radio service company and its affiliates until it reaches its ultimate destination. Messages to the ship are handled in much the same manner.

Communication procedures practiced by merchant ships, regardless of nationality, are comparatively similar to U.S. Navy procedure but less formal, chiefly because of language differences. Operating signals (Q signals) have extensive application in merchant ship communications. They greatly facilitate communications because their meaning is the same translated into any language. Also they enable radio operators to talk among themselves without having the slightest knowledge of one another's language. Normally the receipt method is used. That is, both transmitting and receiving stations are required to use their transmitters, one to send the message, and the other to acknowledge for it.

Messages from shore usually are transmitted during scheduled periods that are published and distributed to merchantmen. A traffic list is sent first. It contains call signs of ships for which messages are held. For example, WCC at Chatham would transmit the following on 500 kHz:

CQ CQ CQ DE WCC WCC WCC
QTC ANS 400 KDVI DKVU
KKIJ KKUV WKIJ WKMM QTC DE
WCC ANS 400 K

The ships listed would then answer in turn on 400 kHz, and each would receive its traffic. Depending on the frequency band within which a station operates, an assigned calling and answering frequency exists for establishing initial contact. Particular attention must be given to prevent transmitting on 500 kHz during the silent periods. Silent periods are reserved for distress messages, and are from 15 to 18 minutes, and 45 to 48 minutes past the hour.

MERCHANT COMMUNICATION EQUIPMENT

All U.S. flag cargo ships over 1600 gross tons are required by law to carry radio telegraph

(CW) equipment. The minimum requirements include main and reserve transmitters that operate between 405 KHz and 535 KHz, main and reserve receivers capable of receiving 100-200 KHz and 405-535 KHz, two separate power supplies, and two antennas. An emergency lighting system for the radio operating area, a reliable clock with the silence periods marked off, and an efficient two-way intercom system between the bridge and the radio room are also mandatory. If there are an insufficient number of operators to stand watch 24 hours a day, an auto alarm must be installed.

An auto alarm receiver is designed to register a certain dash-space auto alarm transmission, which by international agreement all ships will send prior to transmitting an SOS message on 500 KHz. After registering three or four successive, properly made dashes and spaces, the auto-alarm rings a bell in the radio station, on the navigation bridge, and in the radio's operator's living quarters (note that the auto-drum does not stand watch for a SOS but for the auto-alarm signal that should procede any SOS message).

All U.S. ships will also carry a VHF bridge-to-bridge radiotelephone capable of transmitting and receiving on 156.3 MHz (channel 6-safety frequency), 156.8 MHz (channel 16-distress and calling) and 156.65 MHz (channel 13-for U.S. coastal and inland waters). Normally these VHF transceivers are of the multichannel type and many other frequencies are available for use.

All U.S. flag merchant ships over 300 gross tons operating in international waters will also carry a HF radio capable of transmitting and receiving on 2182 kHz (International Distress and Calling) in the radiotelephone (nonsecure) voice and radiotelegraph modes of operation.

MERCHANT RADIO OPERATORS

The radio operator is aboard ship to enable the ship to communicate in case of emergency, to receive distress messages from other ships, to transmit weather reports, to handle messages pertaining to shipping business, and to send and receive routine messages for crew members.

The master has overall responsibility for all communications maintained by his ship, but normally he will delegate the senior radio officer to oversee the operations of the radio room.

Cargo ships usually employ only one radio operator who stands eight hours of watch daily, using the auto-alarm for the remainder of the time. Watch hours are determined by the geographical area in which the ship is operating.

LIMITATIONS OF NAVY-MERCHANT COMMUNICATIONS

Because of the types of equipment and lack of operators aboard merchants, the ability of Navy ships to communicate with merchant ships is severely limited. Merchant ships rely almost exclusively on MF and HF (when installed at the option of the owner) manually keyed telegraphy (CW) for long range communications. The Navy inaugurated the use of radio teletypewriters in the 1950's and uses very little CW today. Further, while Navy ships monitor the international MF distress frequency, 500 KHz, they are not capable of transmitting in that range. Presently, because of the need for real time, secure command and control, the Navy is converting to a satellite communications system. As more ships receive the satellite communications equipment, reliance on HF decreases and, in the future, will be minimal.

At the present time, if a Navy and U.S. merchant ship are within sight of each other, they can communicate using their VHF transceivers. To get a message from a Navy ship to a merchant ship, at longer ranges, it would be sent using HF or satellite radio teletypewriter through the naval communications network to the United States, where it would be refiled with a commercial radio station for transmission to the merchant. Then there may be difficulty in contacting the ship. Owners have reported being out of contact with their ships for up to 48 hours with shore to ship delays through commercial stations averaging six hours. The delays encountered are because of the limited eight hour operator watches, cumbersome international calling procedures, and to some extent, radio propagation conditions. The reverse process should take less time, since the operator delay would be eliminated.

It is obvious that the lack of reliable communications which exists today hampers Navy-Merchant Marine cooperation in an emergency. This fact was demonstrated by the difficulties the SS *Mayaguez* experienced in communicating its predicament when it was illegally seized on the high seas in May 1975.

In 1974 the Safety of Life at Sea (SOLAS) convention recommended that merchant ships maintain a continuous watch on 2182 kHz. This recommendation was implemented by the Federal Communications Commission to be effective on 25 May 1981. Use of this frequency in the

nonsecure voice mode by U.S. Navy ships will provide a reliable callup capability with merchant ships in emergency situations or distress. During normal operations, fleet units or a task force guard ship will maintain a listening watch on 2182 kHz in lieu of 500 kHz to provide an emergency callup capability between merchant ships and U.S. Navy units. The traditional requirement that Navy units at sea keep a listening watch on 500 kHz is rescinded except for commercial ships under Navy charter and USNS ships designated by COMSC. Other commanders may establish a watch on 500 kHz, as the need exists, on a case-by-case basis.

WARTIME MERCHANT SHIP COMMUNICATIONS

In time of war or national emergency, U.S. flag ships must be able to communicate effectively with naval ships and shore stations. This communication may take place at short ranges (such as tactical communications within a convoy) or at very great distances if the merchant is routed independently.

Tactical communications are the means by which an officer in tactical command (OTC) coordinates and controls the movements of units under his command, primarily by either visual or radiotelephone (R/T) messages. Flashing light and flaghoist signaling are used extensively during daylight when units are within visual range, while radiotelephone is used when visual signaling if impractical. R/T is the least secure method of transmission, being subject to interception at great distances by anyone having suitable equipment.

U.S. NAVY POLICY FOR COMMUNICATIONS WITH U.S. MERCHANT SHIPS

Based on the need for rapid and reliable communications with U.S. flag merchant ships in crisis and wartime situations, satellite communications are required to provide the optimum real-time command and control necessary for Navy merchant/marine coordination and protection. This means of communications should be mutually compatible for Navy/merchant ship contract use in peacetime, as well as for Navy control of shipping in a limited war.

U.S. Navy policy for communications with U.S. flag merchant ships is embodied in the following statement:

> "Implicit in the U.S. Navy function of sea control is the broad responsibility for protection of U.S. flag merchant shipping and the capability to effect emergency mobilization of U.S. sealift resources when required. The performance of this function requires rapid and reliable communications with U.S. flag merchant shipping. Satellite communications offers the only available means of efficiently achieving this required level of real-time communications. Satellite communications is considered the ultimate goal; however, it is recognized that existing installations and economics decree some dependence in the immediate future upon high frequency radio teletype. Such dependence requires coupling with effective alerting and error correction devices. Actions to provide these improvements to current HF capability are encouraged. Past and continuing drawdown of Navy high frequency assets, both stations and people, preclude dependence upon Navy for such support, the source for which will have to be interconnected commercial and Coast Guard stations."

In furtherance of this policy, CNO has requested that necessary modification be made to the National Defense Features Criteria for merchant ships and that the Maritime Administration sponsor legislation to promote this policy in both new merchant ship construction and as backfit to older merchant ships as appropriate.

IMPLEMENTATION OF NAVY/MERCHANT SHIP COMMERCIAL SATELLITE COMMUNICATIONS

COMNAVTELCOM will establish and promulgate procedures for Navy/merchant ship communications via commercial maritime satellite systems (INMARSAT) COMNAVTELCOM will also program for and fund commercial refile costs associated with commercial INMARSAT communications services. All naval commands are authorized to communicate with merchant ships using commercial INMARSET procedures promulgated by COMNAVTELCOM for

transmission of emergency messages and messages pertaining to fleet operations. Routine operational and administrative messages and hydrographic and navigational warnings, however, will not be transmitted via commercial INMARSET systems.

FUNDING FOR COMMERCIAL INTERNATIONAL MARITIME SATELLITE (INMARSAT) SERVICES

NTP 10C contains detailed operating procedures for communications with COMSC-controlled and U.S. merchant ships via INMARSAT. Messages are introduced into INMARSAT via the NAVCOMMU Washington Class "E" refile facility or a TELEX installation at COMSC headquarters. It is also possible for other naval activities to access INMARSAT via own TELEX systems after coordinating access procedures with the U.S. COMSAT Corporation or other representatives of the INMARSAT consortium. As indicated in NTP 10C and NTP 5, naval activities can also access INMARSAT for voice communications using local telephone systems or Navy switchboards, depending on the geographic location of the command. Costs incurred by commercial INMARSAT services will be funded as indicated below.

In accordance with INMARSAT billing procedures, commercial carriers submit bills to the TELEX installation, which introduces messages into the INMARSAT system. NAVCOMMU Washington will be billed by commercial carriers for all messages introduced into the INMARSAT system via the Class "E" interface.

NAVCOMMU Washington will forward bills received for INMARSAT service to COMSC, who will determine funding source for payment of bills. If messages were addressed to U.S. flag merchant ships not under COMSC control, COMSC will pay bills citing COMNAVTELCOM commercial refile accounting data.

For messages addressed to ships under COMSC control, COMSC will determine whether bills will be paid by project sponsors, industrial fund, or COMNAVTELCOM commercial refile account and make payment accordingly.

Naval shore activities that use own TELEX systems to deliver/receive messages via INMAR-

Naval CONUS shore activities which use unclassified INMARSAT voice communications will fund and pay costs as billed directly by COMSAT General. Voice procedures are as outlined in NTP 5.

Forces afloat that place unclassified INMARSAT voice calls to merchant ships via NAVCAMS coordination/AUTOVON extension through OPNAVCOMMO or NAVCOMMSTA San Diego interim command switchboard to INMARSAT ground entry stations will not be expected to fund costs. OPNAVCOMMO and NAVCOMMSTA San Diego will fund such services as outlined in NTP 5.

Ships under control of COMSC, and those under contract to COMSC, will fund INMARSAT charges as arranged for by COMSC.

MERCHANT SHIP RADIO COMMUNICATIONS

DMAHTC Pub. 102 is used for unclassified communications between ships of all nations during peacetime. ACP 149 and DMAHTC Pub. 117 contain other frequency information. U.S. merchant ships hold DMAHTC Pub. 117, which explains their actions in case of emergency or war and gives information on U.S. naval commanders and their areas of control.

In case of war emergency, the Navy may control the movements and routing of U.S. merchant ships through the NCSORG (see ATP 2). Instructions for merchant ships for wartime communications are in ACPs 148 and 149. Call signs are listed in ACP 147. In peacetime, the U.S. Navy normally has no control over merchant shipping.

When a merchant ship is under control of the NCSORG during war or other emergency, radio silence may be prescribed, except for certain emergency transmission, such as, contact reports or distress messages (see ACP 149).

A contact report from a merchant ship is a message reporting the sighting of, attack by, or anticipation of attack by suspicious/hostile forces. Alarm signals used by merchant ships in conjunction with contact reports contain four separate letters and are repeated three times. This procedure indicates that the communication is a FLASH message, identifies the type of attack or sighting, and serves as the ultimate address

and ACP 135. In wartime, merchant ships send distress messages only in cases of distress from normal marine causes and not because of enemy action. The form is similar to that of a contact report, the distress signal (SOS) being made three times.

If requested by local naval authority, merchant ships in harbor will maintain a modified radio watch on the harbor frequency. In peacetime, except in emergencies or when specifically authorized, merchant ships do not normally use Navy facilities for ship-to-shore communications.

MERCHANT SHIP BROADCAST (MERCAST)

The MERCAST system is used to deliver U.S. government-originated messages to merchant ships on prior arrangement and for delivery of messages to MSC ships when directed. Coast Guard stations at Portsmouth, VA, Honolulu, HI, and Guam place messages on broadcasts in accordance with previously submitted message routing information. Complete information on the peacetime MERCAST system is outlined in NTP 10 and DMAHTC Publication 117, which list stations, schedules, frequencies, hydrographic data, and ice reports.

During wartime, each MERCAST area is covered by an Allied MERCAST area station, the schedules and frequencies are in ACP 149 series. MERCAST coast stations are available to provide local coverage within each area and transmit traffic at other than scheduled times. Designated Composite Fleet/General broadcast will be

WHO	DOES WHAT
CNO	1. Duty captain originates/releases message. 2. OPNAVCOMMO Programs LDMX to route message to NAVCOMMSTAs, NAVCOMMU Washington and COGARD stations for transmission to merchant ships in accordance with routing profile established by COMNAVTELCOM. Routes message to FLTCINCs for COG.
FLTCINCs	Take message for COG in conjunction with NCSORG responsibility.
NAVCOMMSTAs	1. Where required to guard 500 kHz by communication operating requirements (COR), broadcast the general emergency message every hour for 24 hours. Commence transmission during the last 30 seconds of the first silent period. 2. Place on common channels of fleet broadcasts. 3. Place on all active single channel broadcasts. 4. Place on composite CW broadcasts, transmit at the beginning of each MERCAST, NAVAREA warning, HYDRO and weather schedules for a 24-hour period. 5. Transmit via secondary CW ship/shore, mobile maritime and public correspondence circuits, as applicable.
COGARD Stations	1. Broadcast on 500 kHz every hour for 24 hours commencing transmission during the last 30 seconds of the first silent period. 2. Transmit on broadcast at the beginning of each MERCAST, NAVAREA warning, HYDRO and weather schedules for a 24-hour period.
NAVCOMMU Washington, D.C.	Pass to ITT and RCA operations centers in Washington via TELEX for broadcast to merchant ships via affiliated coastal stations. Coastal stations will broadcast at the beginning of traffic lists four times a day for three consecutive days between 0800 and 2100 local times.

284.81

rescheduled during wartime to accommodate the Allied MERCAST.

THE GENERAL EMERGENCY MESSAGE

This message is used to inform U.S. merchant ships that a state of war or national emergency exists; it places them under U.S. Navy control and instructs them to comply with the Defense Mapping Agency Hydrographic Center (DMAHC) Radio Navigational Aids Publication 117. The general emergency message is disseminated according to figure 15-5 in the following format:

FLASH

(DATE-TIME-GROUP)

FROM: CNO WASHINGTON DC

TO: ALL US CONTROLLED MERCHANT SHIPS

INFO: CINCLANTFLT NORFOLK VA

CINCPACFLT PEARL HARBOR HI

CINCUSNAVEUR LONDON UK

ACCT NA-CNRF

UNCLAS //N00000//

GENERAL EMERGENCY MESSAGE

UNITED STATES IS AT WAR WITH

(or as applicable). MASTERS

OF US CONTROLLED MERCHANT

SHIPS COMPLY WITH

INSTRUCTIONS CONTAINED

IN DEFENSE MAPPING AGENCY

HYDROGRAPHIC CENTER PUB 117,

CHAPTER TEN AND ENVELOPE

ALPHA ON RECEIPT.

CONVOY COMMUNICATIONS

Merchant ships via convoy guard distress frequencies and copy MERCAST schedules as prescribed in the communication plan (see ACP 149). Naval ships in convoy maintain applicable communications watch and copy MERCAST schedules.

The convoy commodore controls all radio communications of ships in his convoy. He determines the priority of use for visual signaling, voice or RTT/CW radio, disseminating it in the communication plan or at the presail conference. The distress frequency (500 and 2182 kHz) is common to all ships in the convoy.

Messages from outside the convoy for an individual convoy ship are usually addressed to the escort force commander with passing instructions; messages to all convoy ships are placed on the MERCAST. Ship-to-shore transmissions are made either by the escort force commander or a ship that person designates.

COMMUNICATIONS IN SUPPORT OF NAVAL CONTROL OF SHIPPING AND CONVOY OPERATIONS

The objective for communications for merchant ships in support of the Naval Control of Shipping Organization (NCSORG) and convoy operations has been defined in Section IV-20, Naval Communications Mid-Range Plan 1980-1990. In July 1980, CNO validated communication requirements, for planning purposes, to support the NCSORG and convoy communications and has taken action to include them in a revision to the mid-range plan as follows:

1. One high frequency secure voice link, ship-shore and ship-ship, for information transfer between the convoy commodore and command headquarters ashore and with the Navy escort commander.
2. One secure ship-shore teletype link from the convoy commodore to command headquarters ashore, in addition to secure broadcast receive capability.
3. One UHF secure voice (VINSON) for line-of-sight (LOS) ship-ship and ship-air communications between the convoy commodore and the Navy escort commander.

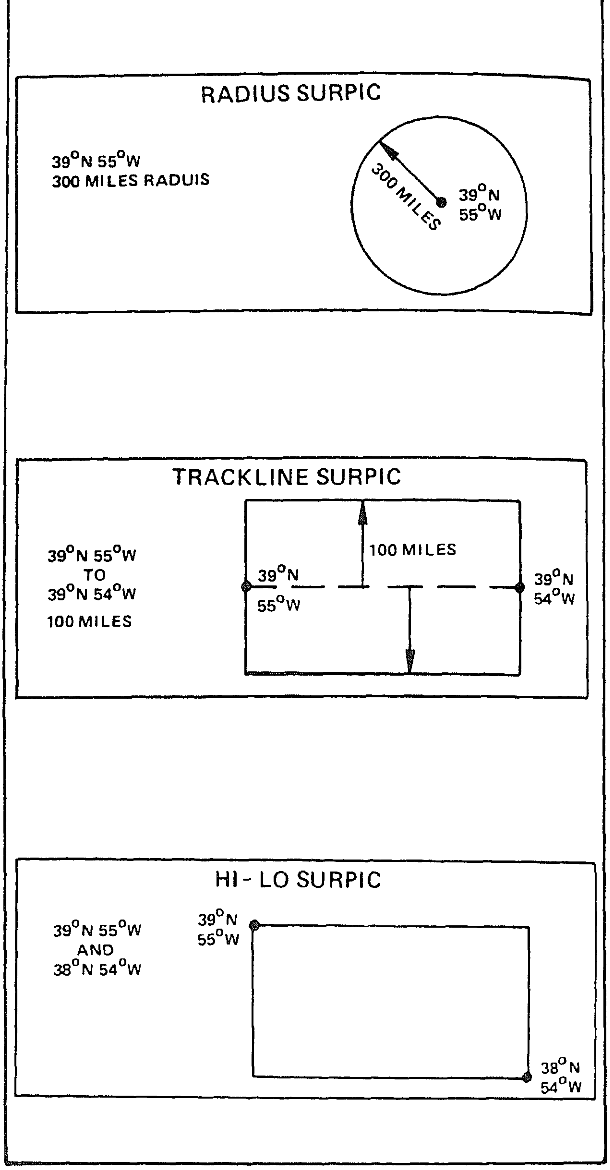
Other ships in the convoy would require off-line crypto capability for security of record communications. Intraconvoy communications between merchant ships and the convoy commodore would employ VHF bridge-bridge non-secure voice communications. During periods of good visibility, escorts use visual communications with convoy ships in accordance with ACP 148.

AUTOMATED MERCHANT VESSEL REPORTING (AMVER) SYSTEM

AMVER is a computerized system for maintaining the dead reckoning navigation position of participating merchant vessels. Merchant vessels of all nations making coastal and oceanic voyages are encouraged to voluntarily send movement reports and periodic position reports to the AMVER center in New York via designated coastal, foreign, or ocean station ship radio stations. Any vessels between 80 degrees North and 80 degrees South worldwide may participate. Information from these reports is entered into a computer, which generates and maintains dead reckoning positions for the vessels during its voyage. Characteristics of each vessel that are valuable for determining SAR capability are also entered into the computer from available sources of information. This SAR data is also published periodically by AMVER and distributed to rescue coordination centers (RCCs) (Coast Guard Publication CG-371).

The AMVER center can deliver, in a matter of minutes, a surface picture (SURPIC) of vessels in the area of a SAR incident, including their predicted positions and their characteristics. This service is available to any RCC throughout the world where established communications links permit, in addition to all U.S. RCCs. SAR mission coordinators (SMCs) handling an oceanic mission of any type should always consider requesting a SURPIC, regardless of whether it appears at the moment that merchant vessel assistance can be used. A SURPIC should be requested any time a mission is classified as in the distress phase or alert phase.

The SURPIC may be requested in three formats: radius, trackline, or hi-lo (fig. 15-6). A radius SURPIC will list all vessels within the distance, specified by the SMC of a distress position, with the closest vessels listed first. A trackline SURPIC between two positions and extending on either side of the track a distance specified by the SMC will list the vessels in order from the first position to the second position. A hi-lo SURPIC will list all vessels within a rectangle bounded by latitude and longitude lines, listed from the first set of coordinates given to the second.



284.82

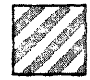
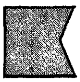
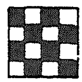
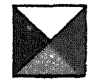
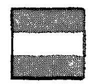
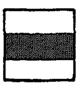
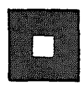
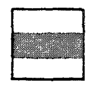
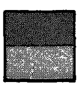
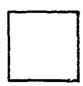
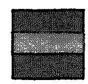
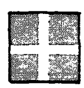
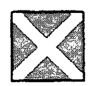
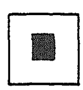
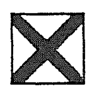
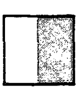
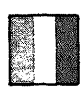
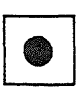
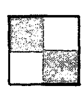
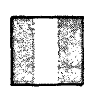
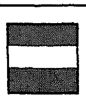
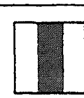
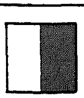
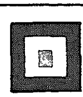
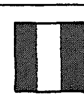
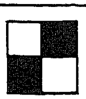
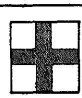
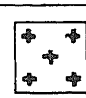
Figure 15-6.—The three SURPIC formats.

FLAGHOIST

Flaghoist signaling provides a rapid, accurate, and relatively secure means of handling tactical and information signals, during daylight, between ships in proximity.

It is rapid because one ship, hoisting one or more flags having a predetermined meaning, can communicate simultaneously with several other ships. It is accurate because all addressees are required to repeat the signal, thus allowing the originator to make sure they have read the signal correctly. A reasonable degree of security is achieved because of visibility range limitations.

For allied signaling all the flags and pennants shown in figures 15-7 and 15-8 are used. For

FLAG and NAME	Spoken	Written	FLAG and NAME	Spoken	Written	FLAG and NAME	Spoken	Written
 A	ALFA	A	 M	MIKE	M	 Y	YANKEE	Y
 B	BRAVO	B	 N	NOVEMBER	N	 Z	ZULU	Z
 C	CHARLIE	C	 O	OSCAR	O	 1	ONE	1
 D	DELTA	D	 P	PAPA	P	 2	TWO	2
 E	ECHO	E	 Q	QUEBEC	Q	 3	THREE	3
 F	FOXTROT	F	 R	ROMEO	R	 4	FOUR	4
 G	GOLF	G	 S	SIERRA	S	 5	FIVE	5
 H	HOTEL	H	 T	TANGO	T	 6	SIX	6
 I	INDIA	I	 U	UNIFORM	U	 7	SEVEN	7
 J	JULIETT	J	 V	VICTOR	V	 8	EIGHT	8
 K	KILO	K	 W	WHISKEY	W	 9	NINE	9
 L	LIMA	L	 X	XRAY	X	 Ø	ZERO	Ø

C17.67

Figure 15-7.—Alphabet and numeral flags.

PENNANT and NAME	Spoken	Written
1	PENNANT ONE	p1
2	PENNANT TWO	p2
3	PENNANT THREE	p3
4	PENNANT FOUR	p4
5	PENNANT FIVE	p5
6	PENNANT SIX	p6
7	PENNANT SEVEN	p7
8	PENNANT EIGHT	p8
9	PENNANT NINE	p9
Ø	PENNANT ZERO	pØ
TACK LINE	TACK	—

PENNANT or FLAG	Spoken	Written	PENNANT or FLAG	Spoken	Written
CODE or ANSWER	CODE or ANSWER	CODE or ANS	NEGATIVE	NEGAT	NEGAT
SCREEN	SCREEN	SCREEN	PREPARATIVE	PREP	PREP
CORPEN	CORPEN	CORPEN	PORT	PORT	PORT
DESIG-NATION	DESIG	DESIG	SPEED	SPEED	SPEED
DIVISION	DIV	DIV	SQUADRON	SQUAD	SQUAD
EMERGENCY	EMERGENCY	EMERG	STARBOARD	STARBOARD	STBD
FLOTILLA	FLOT	FLOT	STATION	STATION	STATION
FORMATION	FORMATION	FORM	SUBDIVISION	SUBDIV	SUBDIV
INTER-ROGATIVE	INTER-ROGATIVE	INT	TURN	TURN	TURN

SUBSTITUTES

1st. SUBSTITUTE	FIRST SUB	1st.	3rd. SUBSTITUTE	THIRD SUB	3rd.
2nd. SUBSTITUTE	SECOND SUB	2nd.	4th. SUBSTITUTE	FOURTH SUB	4th.

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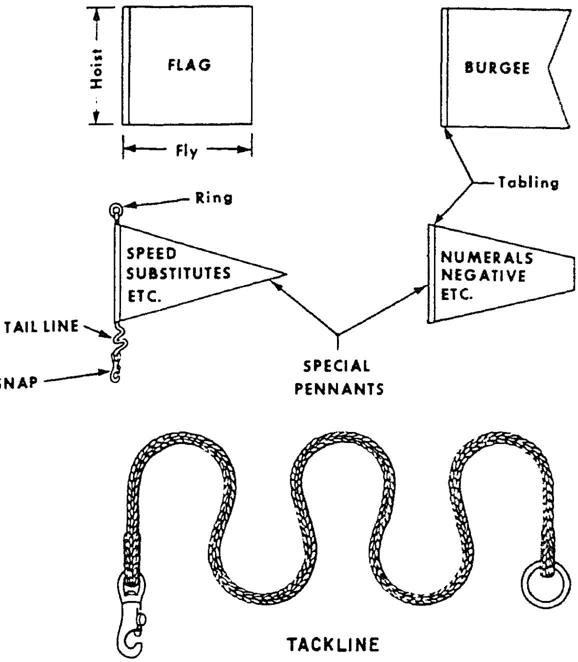
Figure 15-8.—Numeral pennants, special flags and pennants, and substitutes.



69.121

Figure 15-9.—Flag and pennant nomenclature.

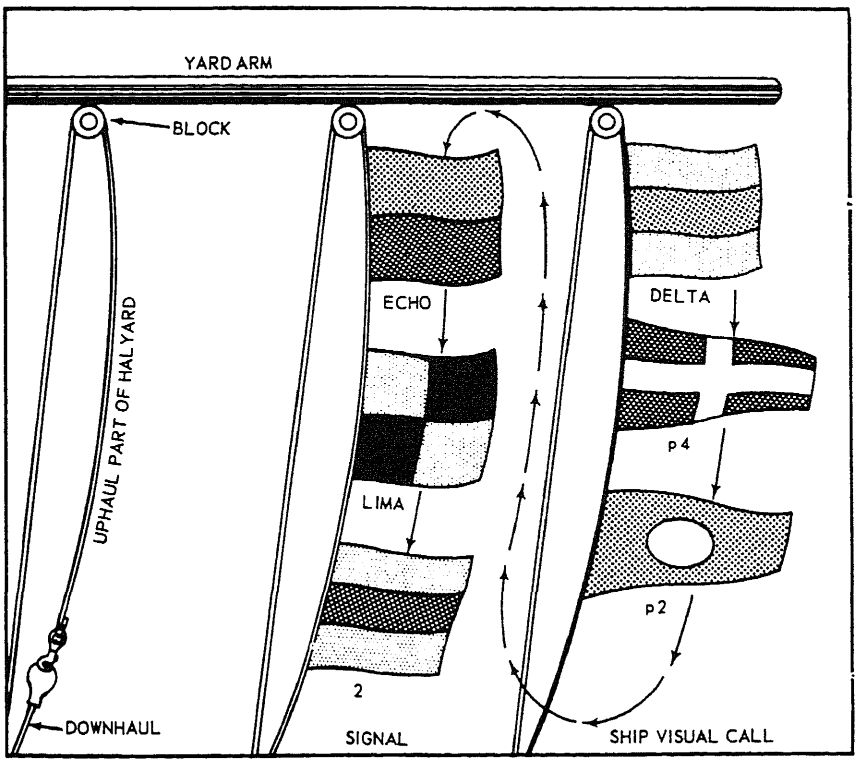
international signaling only, the alphabet flags, the numeral pennants, the CODE/ANSWER pennant, and the substitutes (except the fourth) are used.

Flag and pennant nomenclature are illustrated in figure 15-9. The tackline is a 6-foot length of halyard used to separate flags on the same hoist; which, if not separated, could convey a meaning different from that intended. It is spoken TACK and written as a dash.

The most common locations (points of hoist) of signal halyards are the masthead and the yardarms on the foremast. Some ships use a triatic stay, which is a line running fore and aft between the mast and stack, or similar points.

A hoist is a signal consisting of one or more flags on a single halyard. A display is a complete signal, whether on one hoist or on two or more adjacent hoists.

Signals are read from the top down and, when flying from the yardarm, from outboard in (fig. 15-10). Those flying from the triatic stay are read from forward aft. When displays are flown from different points of hoist, they are read in the following order: masthead, triatic stay, starboard



69.122

Figure 15-10.—Read hoists from top down, outboard in.

yardarm, port yardarm. With yardarms of different heights, the higher one is read first.

When the top of a hoist is touching the point of hoist, it is "close up." When about three-fourths of the way up, it is "at the dip"; and it is "hauled down" when the flags are returned to the deck.

In transmitting a flaghoist signal, the originator hoists the flags close up. Addressees hoist the same signal at the dip, indicating that the signal has been received but not yet decoded. The watch officer decodes the signal and acknowledges receipt by ordering the flaghoist closed up. When all addressees have acknowledged the signal, the originator hauls his display down. If it is a maneuvering signal, that is the moment of execution, unless a time of execution has been specified.

Quite often there are ships which cannot see the OTC's (or other originator's) ship or cannot read his flaghoist signals. In such situations it is the responsibility of ships in positions to do so to relay messages to other ships in the direction away from the originating ship. Although ships may be designated "repeating ships," it is the duty of any ship to relay signals when it is evident that it is in a better position to do so than a ship specifically responsible. A relaying ship may not acknowledge a signal until ships to which it is relaying have done so.

SIGNALS USED IN CONVOY

Ships in convoy will use the signals provided in the *International Code of Signals* (Pub. No. 102), Annex C to *Allied Guide to Masters* (ACP 148) and "Q" codes. These signals may be transmitted by visual means or voice radio (subject to the radio policy in force).

When naval ships communicate with merchant vessels using signals from Pub 102, the hoist will be preceded by the CODE (ANSWER) pennant. To indicate a visual signal is from ACP-148, naval ships will start the flaghoist with the fourth substitute pennant. Merchant ships should use the same procedures to communicate with an allied naval vessel that is not part of the convoy.

SIGNAL CONSTRUCTION

Messages transmitted by flaghoist consist, with certain exceptions, of a heading (call) and a text. Unless a signal from a superior is addressed to an individual unit within a group, the heading is omitted, with the understanding that the signal is addressed to all ships. When a junior hoists a signal with no call, it is addressed to the superior.

VISUAL CALL SIGNS

Convoy visual call signs are established on the basis of each ship's position in the convoy. The call signs of individual ships, regardless of their special duties, are the numerical pennants corresponding to their convoy number. Specific information on the method of numbering convoy positions is contained in ACP 148.

Governing Pennants

Three governing pennants—PREPARATIVE, INTERROGATIVE, and NEGATIVE—are available to impart a special sense to a signal. When hoisted with signals, their meanings are as follows:

Pennant	Preceding the Signal
PREP	Prepare to _________ .
INT	Questions or inquires.
NEGAT	Cease, do not _________ , or gives a negative sense to an otherwise affirmative (informatory) statement.

In the following examples, assume that AV means "Launch aircraft."

Signal	Meaning
PREP AV	Prepare to launch aircraft
INT AV	Are you launching aircraft?
NEGAT AV	Do not launch aircraft, or cease launching aircraft.

A governing pennant governs all signal groups when separated from those groups by TACK or when hoisted alone on an adjacent halyard. If the pennant is to govern only one of several signal groups, it must immediately precede the group governed. The other groups must be separated from the governed group by TACK.

Substitutes

Whenever possible, substitutes are used to prevent alphabet flags, numeral flags, or numeral

pennants from appearing more than once in the same hoist. As their names imply, they are substitutes for other flags or pennants used in the hoist.

FIRST SUB repeats the first flag or pennant in the hoist.

SECOND SUB repeats the second flag or pennant in the hoist.

THIRD SUB repeats the third flag or pennant in the hoist.

FOURTH SUB repeats the fourth flag or pennant in the hoist.

To illustrate, the signal CORPEN ZERO ZERO ZERO would read

CORPEN

ZERO

2nd

3rd

SECOND SUB repeats the second flag, and THIRD SUB repeats the third flag, which already repeats ZERO.

When more than one halyard is used to hoist a signal, each hoist is considered separately as regards substitutes. When a tackline separates hoist components, it is disregarded in the substitute count.

ANSWER Pennant

Fractions or decimals are indicted by the use of the ANSWER pennant. When following a numeral, ANSWER stands for one-half of one of the units to which the preceding numeral referred. For example, if TURN 4 means "Turn 40 degrees to the right of present base course," then TURN 4 ANSWER means "Turn 45 degrees, to the right of present base course." If SPEED A 10 means "Proceed at 10 knots," SPEED A 10 ANSWER means "Proceed at 10.5 knots."

When inserted between numerals, ANSWER acts as a decimal point. SPEED A 10 ANSWER 2, for instance, means "Proceed at 10.2 knots."

Description Signal

A description signal, used to supplement a signal group, normally describes own or enemy forces or conveys other information. A description signal consists of DESIG, followed by numerals, letters, or groups necessary to amplify the meaning of the signal. For example, a flaghoist reporting the sighting of enemy forces might be supplemented by DESIG 2F, which would indicate the forces were composed of two frigates.

When appropriate, DESIG, followed by letters and/or numerals, indicates that such a group is to be interpreted literally. In this way, words may be spelled out within the text of a signal to complete or modify the meaning. For example, to spell out the word "yes," the hoist would be—

DESIG pennant

YANKEE flag

ECHO flag

SIERRA flag

Because spelling out words requires a large number of flags, plain text is never used in flaghoist signals when the same information can be conveyed by code.

Single Flags and Pennants

When two or more single flags or pennants are shown in the same hoist, they must be separated by TACK. Single flags or pennants may be hoisted also with groups from the signal book if separated from the group and themselves by TACK.

CONVOY COLORED LIGHT SIGNALS

Convoy colored lights is a system of communication that has been adopted to enable the convoy commodore to communicate at night when voice radio communications are not available. The signal lights consist of three red and three green lights with an all-round area of visibility. The lights are arranged vertically in alternating colors, starting with red and are hoisted a minimum of ten feet above the funnel.

The colored light signals are contained in Annex D to ACP-148. When the commodore shows a signal, all ships of the convoy repeat the signal. The signal is executed when the commodore extinguishes his lights.

FLASHING LIGHT

Flashing light tactical communication employs visible and infrared light beams to transmit Morse code characters. (Infrared is used only at night. Visible flashing light may be used at night in peacetime.) Both directional and nondirectional transmissions are possible.

Standard Navy searchlights fitted with hand-operated shutters are used for directional signaling. Nondirectional signaling uses yardarm blinkers (one on the end of each yardarm), operated by a telegraph key.

For directional infrared signaling, a hood having a special lens is fitted to the searchlight. The light is operated in the usual manner, but searchlight train must be more accurate. For nondirectional signaling, there are two infrared beacons mounted either inboard of the yardarm blinkers or on a separate support on the mast. They can operate in the same manner as the blinkers, or they can provide a steady light as a point of aim on which other ships train their lights for directional infrared signaling. Although infrared signaling requires special viewing equipment and precise signal light aiming, it is especially useful in wartime because of the security provided. When a ship desires to communicate with another via infrared signaling, it transmits "Nancy Hanks" over a radiotelephone circuit.

Tactical signals may be sent by flashing light, but because of the need to relay the signals to outlying units, their execution becomes more difficult as the number of ships increases. Nondirectional signaling eases the task, but the range is not as great as directional signaling, and visible light normally cannot be used at night in wartime.

When flashing light is used for tactical signals, the executive method is employed. In the delayed executive method, the signal is receipted for by receiving stations, and the signal is executed by a later transmission. In the immediate executive method, only one transmission is made—the signal is sent twice, then executed. In both methods the moment of execution is the termination of a 5-second flash.

RADIOTELEPHONE

Radiotelephone (voice radio) provides the only "real-time" means of communication among units. Because of its directness, convenience, and ease of operation, voice radio is used extensively between ships and between ships and aircraft for short-range tactical communications.

There can be certain drawbacks to using voice radio. There is no transmission security, which means that anyone having the proper equipment can intercept signals. Also, poor voice communications, whether because of faulty equipment, adverse atmospheric conditions, or inept performance by an operator, can create confusion, reduce reliability and speed, and adversely affect operations. It is essential, therefore, that all users strictly observe established operating procedures. Basic guidance for voice radio communications is contained in *Radio Communication Instructions for Merchant Ships Under Naval Control* (ACP 149). Additional signaling instructions for ships in a convoy are found in Annex A to ACP 148.

SECURITY

In the interest of security, transmissions by radiotelephone should be as short and concise as possible, consistent with clearness. All operators must be cautioned that transmissions by radiotelephone are subject to enemy interception and, therefore, have no security.

The following basic rules are essential to transmission security and are to be strictly enforced on all military radiotelephone circuits.

1. No transmission will be made that has not been authorized by proper authority.
2. The following practices are specifically forbidden:

   Violation of radio silence

   Unofficial conversation between operators

   Transmitting on a directed net without permission

   Excessive tuning and testing

   Transmitting the operator's personal sign or name

   Unauthorized use of plain language

   Use of other than authorized prowords

   Unauthorized use of plain language in place of applicable prowords or operating signals

Linkage or compromise of classified call signs and address groups by plain language disclosures or association with unclassified call signs

Profane, indecent, or obscene language

3. The following practices are to be avoided:

Use of excessive transmitting power

Excessive time consumed in tuning, changing frequency, or adjusting equipment

Transmitting at speeds beyond the capabilities of receiving operators

TYPES OF NETS

A radio net consists of two or more stations capable of direct communications on a common circuit. A station is designated as net control to direct the operation and flow of traffic on the net. The type of net and method of operation is determined by the operational factors involved. There are two types of nets: free and directed.

In a free net, the net control station (NCS) authorizes stations to transmit traffic to other stations without first obtaining permission from NCS. However, the NCS is not relieved of responsibility for maintaining circuit discipline.

In a directed net, stations must obtain permission from NCS prior to communicating with other stations. When two or more stations have traffic to send, NCS grants permission in order of message precedence. An exception is that Flash messages may be sent direct.

A net is deemed to be a free net unless otherwise ordered. To change the type of net in effect, the NCS will transmit "This is a free net," or "This is a directed net," as appropriate.

Free and directed nets are generally associated with, but are not restricted to, administrative circuits in port. They are a means of net operation and should not be confused with specifically named circuits; for example, Task Group Tactical/Warning Net, Task Group Reporting Net, or Naval Gunfire Control Net.

CIRCUIT LOGS

Circuit logs are maintained, when practicable, on all radiotelephone nets or circuits. The log should show a complete record of all transmitted and received traffic and of operating conditions. The log should also include the following:

1. Time of entering and leaving the circuit
2. Causes of delays on the circuit
3. Frequency adjustments and changes
4. Unusual occurrences, such as procedure and security violations

Messages addressed to or to be relayed by the receiving station are written in full on a message blank; thus, only sufficient data need be entered in the log to identify the message (e.g., time of receipt, originator, and date/time group). Other messages should be logged with as much detail as possible. A watch-to-watch record of circuit operators is kept, with each operator signing the log when that person is relieved.

No entries will be erased. Necessary changes are made by drawing a single line through the original entry then entering the change adjacent to the lined-out entry. The operator making the change initials the correction, usually in the margin. All entries must be legible. Abbreviations may be used, but they must be readily understood. A zero is written Ø to avoid confusion with the letter O; the letter Z is written with a bar across its riser (Ƶ) to avoid confusion with the numeral 2.

In connection with circuit logs, the following terms identify the requirements of different types of radio watches.

GUARD—A continuous receiver watch with a transmitter ready for immediate use. A complete log is kept.

COVER—A continuous receiver watch. A transmitter is tuned and available, but not necessarily immediately. A complete log is required.

COPY—A continuous receiver watch with a complete log.

LISTEN—A continuous receiver watch. A complete log is optional, but all traffic of interest to own ship must be logged.

Although logs may be kept manually, automatic recording devices should be used whenever possible on circuits requiring complete logs.

PHONETIC ALPHABET

Because it is easy to confuse the sounds of certain letters, such as B and D, and C and Ƶ,

letters of the alphabet are never spoken as such. Instead, their phonetic equivalents are used. When signals from naval signal books are transmitted by voice radio, the voice equivalents of the flags are used. In the list that follows, the accent is on the capitalized syllable.

Letter	Phonetic Equivalent	Pronounced As
A	ALFA	AL fah
B	BRAVO	BRAH voh
C	CHARLIE	CHAR lee
D	DELTA	DELL tah
E	ECHO	ECK oh
F	FOXTROT	FOKS trot
G	GOLF	GOLF
H	HOTEL	Hoh TELL
I	INDIA	IN dee ah
J	JULIETT	JEW lee ett
K	KILO	KEY loh
L	LIMA	LEE mah
M	MIKE	MIKE
N	NOVEMBER	No VEM ber
O	OSCAR	OSS cah
P	PAPA	Pah PAH
Q	QUEBEC	Keh BECK
R	ROMEO	ROW me oh
S	SIERRA	See AIR rah
T	TANGO	TANG go
U	UNIFORM	YOU nee form
V	VICTOR	VIK tah
W	WHISKEY	WISS key
X	XRAY	ECKS ray
Y	YANKEE	YANG key
Z	ZULU	ZOO loo

PROWORDS

Prowords (procedure words) are pronounceable words or phrases that have been assigned meanings for the purpose of expediting message handling on radiotelephone circuits. Prowords are not to be substituted for textual components.

The prowords contained in table 15-3 are authorized for general use. Certain of these prowords are the approximate equivalent of prosigns used in radiotelegraph. When copying messages, the equivalent prosign may be written rather than the proword. For radiotelephone communication between units of different nationalities, equivalent prosigns may be used instead of prowords. When so used, they are transmitted phonetically.

The prowords listed below are for use when initiating and answering queries concerning signal strength and readability:

1. General:

RADIO CHECK	What is my signal strength and readability; that is, how do you hear me?
ROGER	I have received your last transmission satisfactorily. The omission of comment on signal strength and readability is understood to mean that reception is loud and clear. If reception is other than loud and clear, it must be described with the prowords from subparagraphs (2) and (3) below.
NOTHING HEARD	To be used when no reply is received from a called station.

2. Report of signal strength:

LOUD	Your signal is very strong.
GOOD	Your signal strength is good.
WEAK	Your signal strength is weak.
VERY WEAK	Your signal strength is very weak.
FADING	At times your signal strength fades to such an extent that continuous reception cannot be relied upon.

3. Report of readability:

CLEAR	Excellent quality.
READABLE	Quality is satisfactory.
UNREADABLE	The quality of your transmission is so bad that I cannot read you.
DISTORTED	Having trouble reading you because your signal is distorted.
WITH INTERFERENCE	Having trouble reading you because of interference.
INTERMITTENT	Having trouble reading you because your signal is intermittent.

Table 5-3.—Prowords

PROWORD	EXPLANATION	EQUIVALENT TO
ADDRESS GROUP	The group that follows is an address group.	
ALL AFTER	The portion of the message to which I have reference is all that which follows ______.	AA
ALL BEFORE	The portion of the message to which I have reference is all that which precedes ______.	AB
AUTHEN-TICATE	The station called is to reply to the challenge which follows.	
AUTHEN-TICATION IS	The transmission authentication of this message is . . .	
BREAK	I hereby indicate the separation of the text from other portions of the message.	$\overline{\text{BT}}$
CALL SIGN	The group that follows is a call sign.	
CORRECT	You are correct, or what you have transmitted is correct.	C
CORREC-TION	An error has been made in this transmission. Transmission will continue with the last word correctly transmitted.	EEEEEEEE
	An error has been made in this transmission (or message indicated). The correct version is _____ .	C
	That which follows is a corrected version in answer to your request for verification.	C
DISRE-GARD THIS TRANS-MISSION—OUT	This transmission is in error. Disregard it. This proword shall not be used to cancel any message that has been completely transmitted and for which receipt or acknowledgement has been received.	EEEEEEEE $\overline{\text{AR}}$
DO NOT ANSWER	Stations called are not to answer this call, receipt for this message, or otherwise transmit in connection with this transmission. When this proword is employed, the transmission shall be ended with the proword OUT.	F
EXECUTE	Carry out the purport of the message or signal to which this applies. To be used only with the executive method.	$\overline{\text{IX}}$ (5-sec dash)
EXECUTE TO FOLLOW	Action on the message or signal which follows is to be carried out upon receipt of the proword EXECUTE. To be used only with the delayed executive method.	$\overline{\text{IX}}$
EXEMPT	The addressees immediately following are exempted from the collective call.	XMT
FIGURES	Numerals or numbers follow.	
FLASH	Precedence Flash.	Z
FROM	The originator of this message is indicated by the address designator immediately following.	FM

Table 15-3.—Prowords—Continued

PROWORD	EXPLANATION	EQUIVALENT TO
GROUPS	This message contains the number of groups indicated by the numeral following.	GR
GROUP NO COUNT	The groups in this message have not been counted.	GRNC
I AUTHEN-TICATE	The group that follows is the reply to your challenge to authen-ticate.	
IMME-DIATE	Precedence Immediate.	O
IMMEDI-ATE EXECUTE	Action on the message or signal following is to be carried out on receipt of the word EXECUTE. To be used only with the immediate executive method.	$\overline{\text{IX}}$
INFO	The addressees immediately following are addressed for information.	INFO
I READ BACK	The following is my response to your instructions to read back.	
I SAY AGAIN	I am repeating transmission or portion indicated.	$\overline{\text{IMI}}$
I SPELL	I shall spell the next word phonetically.	
I VERIFY	That which follows has been verified at your request and is repeated. To be used only as a reply to VERIFY.	
MESSAGE	A message which requires recording is about to follow. Transmitted immediately after the call. (This proword is not used on nets primarily employed for conveying messages. It is intended for use when messages are passed on tactical or reporting nets.)	
MORE TO FOLLOW	Transmitting station has additional traffic for the receiving station.	B
NET NOW	All stations are to net their radios on the unmodulated carrier wave which I am about to transmit.	
NUMBER	Station serial number.	NR
OUT	This is the end of my transmission to you and no answer is required or expected.	$\overline{\text{AR}}$
OVER	This is the end of my transmission to you and a response is necessary. Go ahead; transmit.	K
PRIORITY	Precedence Priority.	P
READ BACK	Repeat this entire transmission back to me exactly as received.	G
RELAY (TO)	Transmit this message to all addressees (or addressees immediately following this proword). The address component is mandatory when this proword is used.	T

Table 15-3.—Prowords—Continued

PROWORD	EXPLANATION	EQUIVALENT TO
ROGER	I have received your last transmission satisfactorily.	
ROUTINE	Precedence Routine.	R
SAY AGAIN	Repeat all of your last transmission. Followed by identification data means "Repeat ______ (portion indicated)."	$\overline{\text{IMI}}$
SERVICE	The message that follows is a SERVICE message.	
SIGNALS	The groups which follow are taken from a signal book. (This proword is not used on nets primarily employed for conveying signals. It is intended for use when tactical signals are passed on nontactical nets.)	
SILENCE (Repeated three or more times.)	Cease transmissions on this net immediately. Silence will be maintained until lifted. (When an authentication system is in force, the transmission imposing silence is to be authenticated.)	$\overline{\text{HM}}$ $\overline{\text{HM}}$ $\overline{\text{HM}}$
SILENCE LIFTED	Silence is lifted. (When an authentication system is in force, the transmission lifting silence is to be authenticated.)	
SPEAK SLOWER	Your transmission is at too fast a speed. Reduce speed of transmission.	
THIS IS	This transmission is from the station whose designator immediately follows.	DE
TIME	That which immediately follows is the time of date time group of the message.	
TO	The addressees immediately following are addressed for action.	TO
UNKNOWN STATION	The identity of the station with whom I am attempting to establish communication is unknown.	$\overline{\text{AA}}$
VERIFY	Verify entire message (or portion indicated) with the originator and send correct version. To be used only at the discretion of or by the addressee to which the questioned message was directed.	J
WAIT	I must pause for a few seconds.	$\overline{\text{AS}}$
WAIT-OUT	I must pause longer than a few seconds.	$\overline{\text{AS}}$ $\overline{\text{AR}}$
WILCO	I have received your signal, understand it, and will comply. To be used only by the addressee. Since the meaning of ROGER is included in that of WILCO, the two prowords are never used together.	
WORD AFTER	The word of the message to which I have reference is that which follows ______.	WA

Table 5-3.—Prowords—Continued

PROWORD	EXPLANATION	EQUIVALENT TO
WORD BEFORE	The word of the message to which I have reference is that which precedes ________.	WB
WORDS TWICE	Communication is difficult. Transmit (transmitting) each phase (or each code group) twice. This proword may be used as an order, request, or as information.	
WRONG	Your last transmission was incorrect. The correct version is _____.	

GENERAL PROCEDURES

The following is a guide to developing good microphone technique. Succeeding topics will address specific situations.

1. Listen before transmitting. Unauthorized break-in causes confusion and often blocks a transmission in progress to the extent that neither transmission gets through.

2. Speak clearly and distinctly. Both slurred syllables and clipped speech are hard to understand. A widespread error among untrained operators is failure to emphasize vowels sufficiently.

3. Speak slowly. Give the recorder a chance to get it all down; that way you save time and avoid repetitions.

4. Avoid extremes of pitch. A high voice cuts through interference best, but is shrill and unpleasant if too high. A lower pitch is easier on the ear, but is difficult to understand through background noises if too low.

5. Be natural. Maintain a normal speaking rhythm. Group words in a natural manner. Send your message phrase by phrase instead of word by word.

6. Use standard pronunciation. Speech with sectional peculiarities is difficult for persons from other parts of the country to understand. Talkers who use as a model the almost standard pronunciation of a broadcast network announcer are easiest to understand.

7. Speak in a moderately strong voice to override unavoidable background noises and prevent dropouts.

8. Keep correct distance between lips and microphone. A distance of about 2 inches is correct for most microphones. If the distance is too great, speech is inaudible and background noises creep in; if too small, blaring and blasting result.

9. Shield your microphone. Keep your head and body between noise-generating sources and the microphone while transmitting.

10. Keep the volume of a handset earphone low.

11. Keep speaker volumes to a moderate level.

12. Give an accurate evaluation in response to a request for a radio check. A transmission with feedback or a high level of background noise is not "loud and clear," even though the message can be understood.

13. Pause momentarily, after each normal phrase, and interrupt your carrier. This method allows any other station with higher precedence traffic to break in.

14. Adhere strictly to prescribed procedures.

15. Transact your business and get off the air. Preliminary calls waste time when communications are good and the message is short. It is not necessary to blow into a microphone to test it, nor to repeat portions of messages when no repetition is requested.

Pronouncing Numerals

The proword FIGURES may be used before the numbers to distinguish numerals from words similarly pronounced. Numerals are pronounced as follows:

Numeral	Spoken as
Ø	ZE ro
1	Wun
2	TOO
3	TREE
4	FOW er
5	FIFE
6	SIX
7	SEV en
8	AIT
9	NIN er

The numeral Ø is always spoken as "zero"—never as "oh." Decimal points are spoken as "day-see-mal."

In general, numbers are transmitted digit by digit, except that exact multiples of thousands are spoken as such. However, there are special cases, such as:

1. Anti-Air Warfare reporting procedures, when the normal pronunciation of numerals is prescribed and this rule does not apply. For example, 17 would then be "seventeen."
2. In conduct of Artillery Fire when for fire orders, the pronunciation of whole hundreds is "hundred" instead of "zero zero." For example, 100 would be spoken as "one hundred," 200 would be spoken as "two hundred," and so on.

EXAMPLES:

Number	Pronounced
44	Fow-er Fow-er
90	Nin-er Ze-ro
136	Wun Tree Six
500	Fife Ze-ro Ze-ro
1478	Wun Fow-er Sev-en Ait
7000	Sev-en Tou-zand
16,000	Wun Six Tou-zand
812,681	Ait Wun Too Six Ait Wun

CALL SIGNS

Merchant ships are assigned international call signs by their national authorities in accordance with international agreements. They shall not be used in time of war; except for communicating with neutral ships and stations, in cases of distress or emergency, or when not in convoy and a war radio call sign has not been assigned.

National interim war radio call signs may have been assigned by national authorities for national naval control of shipping in an emergency before national merchant ships can reach a national, allied or neutral port and prior to implementation of the allied naval control of shipping organization. These call signs may be used only for communication by or with national authorities and radio stations.

Merchant ship war radio call signs are assigned to merchant ships prior to sailing by the NCSO. They are used as follows:

1. In broadcast transmissions by shore stations to indicate messages for individual ships.

2. By merchant ships broadcasting alarm reports, distress messages or plain language amplifying reports when not in convoy.

3. By independent merchant ships when communicating with allied naval shore stations in plain language.

4. As a signature in messages to OCA. Individual war radio call signs are designed to conceal the identity of the merchant ships.

To prevent compromise, war radio call signs and international call signs should not be used in the same message, and all subsequent calls and repetitions pertaining to the original message should use the war radio call sign.

CONVOY INTERNAL CALL SIGNS

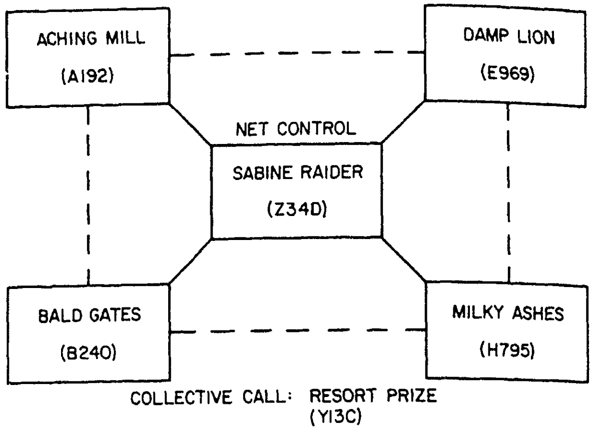
As in visual signaling, voice radio call signs used within a convoy are the same as the ship's convoy number. When transmitted by radio, this number should be preceded by the word SHIP.

Special call signs within a convoy are given in Table 15-4.

Convoy internal call signs should be used only between ships within a convoy, between ships of the convoy and the escort force and with supporting aircraft on short range communications channels. They should never be used when communicating with shore stations or for contacting naval forces outside the convoy or escort. ACP 149 contains additional information on call signs.

Establishing Communications

Figure 15-11 illustrates a radiotelephone net and shows both voice and tactical call signs. (These calls have no particular meaning, being merely representative of procedures. The operating forces currently employ a method of daily changing call signs.)



153.19

Figure 15-11.—Radiotelephone net.

Table 5-4.—Special Internal Convoy Call Signs

Ship or Authority	Transmitted by: Voice Radio/ Flashing Light/ CW
Commodore	BULL
Vice Commodore	CALF
Rear Commodore	COLT
Convoy Collective	HERD
This, or . . section	BEEF
OTC	BOSS
Escort ships collective	GANG
Escort ships individual	CHAP*
Rescue ships	CORK*
Guided missile ship	SHOT*
Escorting aircraft	LARK*
Stragglers	LAZY

*/Followed by 1, 2, etc. as necessary

Full call signs are used when opening a net, reopening a net, or reporting into a previously established net. Abbreviated calls may be used thereafter at the discretion of the net control station. (Abbreviated calls are indicated in sample transmissions by enclosing optional words or phrases within parentheses.)

When ready to establish a net, the net control station transmits—

RESORT PRIZE — THIS IS SABINE RAIDER — OVER

All stations answer in alphabetical order of the first word of their call sign (even when abbreviated calls are used):

THIS IS ACHING MILL — OVER
THIS IS BALD GATES — OVER
Etc.

If a station fails to reply within a few seconds, the next station in order answers, and the delinquent station reports after all other stations have done so. If he so desires, the NCS may then permit the use of abbreviated calls:

RESORT PRIZE — THIS IS SABINE RAIDER — ABBREVIATED CALL SIGNS AUTHORIZED THIS NET — OUT

To establish a directed net, NCS transmits—

RESORT PRIZE — THIS IS SABINE RAIDER — THIS IS A DIRECTED NET — OF WHAT PRECEDENCE AND FOR WHOM ARE YOUR MESSAGES — OUT

(THIS IS) ACHING MILL — NO TRAFFIC — OVER

(THIS IS) BALD GATES — ONE ROUTINE FOR YOU — OVER

(THIS IS) DAMP LION — NO TRAFFIC — OVER

(THIS IS) MILKY ASHES — ONE IMMEDIATE FOR DAMP LION — OVER

(RESORT) PRIZE — (THIS IS) (SABINE) RAIDER — ROGER — MILKY ASHES — SEND YOUR IMMEDIATE — OUT

Under good operating conditions, particularly on large sets, the proword THIS IS may be omitted by the receiving station. When there are only two stations on a net, the entire call may be omitted.

GENERAL OPERATING RULES

Although R/T uses three message forms—plaindress, abbreviated plaindress, and codress—the form most used is the abbreviated plaindress. However, the three major message parts are still used: heading, text, and ending.

Plaindress

In a plaindress message the originator and addressee are indicated externally of the text. It contains all the components of the message format, and must always include precedence and date/time group. The proword MESSAGE normally is used only on nonadministrative (i.e., on tactical and warning) nets as a warning that a message requiring recording is about to follow.

RESORT PRIZE — THIS IS SABINE RAIDER — MESSAGE — PRIORITY — TIME 121545Z FEB 84 — FROM — SABINE RAIDER — TO — RESORT PRIZE — GROUPS 8 — BREAK — UNCLAS MAKE PREPARATIONS TO GET UNDERWAY AT 121830R —BREAK — OVER

Abbreviated Plaindress

The heading of an abbreviated plaindress message is much shorter than that of a plaindress message, one reason being that the precedence, date/time group, and/or group count may be omitted. The call may also serve as the address, and abbreviated calls may be used.

PRIZE — THIS IS RAIDER — BREAK — UNCLAS MAKE PREPARATIONS TO GET UNDERWAY AT 121830R — BREAK — TIME 1545Z — OVER

The time given in the ending is the time of origin and replaces the date/time group in the heading.

Codress

In a codress message the entire address is encrypted within the text. The heading contains only enough information to enable communication personnel to identify and handle the message properly.

The text, following the encrypted heading, consists of 5-character groups, 10 groups to the line. Each group is spelled phonetically even though an occasional group might be pronounceable.

Radio Checks

The words RADIO CHECK comprise a query by a sending station regarding its signal strength and readability (see proword table). If the sender is being received loud and clear, the receiver simply transmits the proword ROGER. If reception is other than loud and clear, the sender's signal strength and readability (in that order) must be reported.

(Y1)3C — THIS IS (Ƶ3)4D — RADIO CHECK — OVER

THIS IS 92 — ROGER — OVER

THIS IS 4Ø — WEAK BUT READABLE — OVER

THIS IS 69 — ROGER — OVER

THIS IS 95 — ROGER — OVER

Hearing all stations loud and clear, NCS transmits—

THIS IS 4D —ROGER — OUT

(NOTE: It should be understood that single letters, where appearing in transmission examples, are pronounced phonetically, for example, "4D" is pronounced "Four Delta"; time zone designator "R" is pronounced "Romeo"; and so on.)

Repetitions

When part of a message is missed or is doubtful, a repetition is requested by the receiving

station before receipting for the message. The proword SAY AGAIN used alone or in conjunction with "ALL BEFORE ____," "ALL AFTER ____," " TO ____," "WORD BEFORE ____," or "WORD AFTER ____" is used for this purpose.

DAMP LION — THIS IS SABINE RAIDER — SEND MESSENGER FOR GUARD MAIL — OVER

Damp Lion, being doubtful of the word "Guard," transmits—

THIS IS DAMP LION — SAY AGAIN WORD AFTER FOR — OVER

THIS IS RAIDER — I SAY AGAIN WORD AFTER FOR — GUARD — OVER

DAMP LION — ROGER — OUT

Correction During Transmission

When an error is made by a transmitting operator, the proword CORRECTION is transmitted followed by the last word, group, or phrase correctly transmitted. The message is then completed. Corrections must be made before the ending proword is transmitted; otherwise a separate message must be sent, correcting the first message.

ACHING MILL — THIS IS SABINE RAIDER — PRIORITY ZULU BRAVO ALFA XRAY XRAY — XRAY OSCAR OSCAR — CORRECTION — ZULU BRAVO ALFA XRAY XRAY — BRAVO OSCAR OSCAR KILO SIERRA — etc.

Cancellations

A message may be canceled at any time prior to transmitting the ending proword. The cancelling proword is DISREGARD THIS TRANSMISSION — OUT.

PRIZE — THIS IS RAIDER — ROUTINE — TIME 231345Z — CONDUCT RADIO CHECKS COMMENCING 010330Z IN ORDER CHANNELS EIGHT —DISREGARD THIS TRANSMISSION — OUT

A message that has been sent and receipted for can be canceled only by another message.

PRIZE — THIS IS RAIDER — CANCEL MY 281345Z — TIME 281730Z — OVER

Acknowledgements

When an originator desires confirmation that his message can (or will) be acted upon, he may request an acknowledgement from the addressee. The request is included in the text. The message is receipted for in the usual manner, but only the commanding officer or his duly authorized representative can acknowledge a message.

95 — THIS IS 4D —SEARCH AREA BRAVO FOR POSSIBLE PLANE WRECKAGE — ACKNOWLEDGE — TIME 1445Z — OVER

THIS IS 95 — ROGER — OUT

The commanding officer, after reading the message, orders the operator to acknowledge.

4D — THIS IS — 95 — YOUR 1445Z ACKNOWLEDGED — TIME 1450Z — OVER

If the commanding officer had heard and understood the message and directed acknowledgement, the operator would have replied—

THIS IS 95 — WILCO — OUT

Verification

When a receiving station requests verification of a message or portion thereof, the sending station will check with the originator and send the correct version even though the original transmission was correct.

4D — THIS IS 40 — VERIFY YOUR 271120Z — ALL BEFORE BREAK — OVER

The operator checks with the originator, establishes that the heading is correct, and transmits—

40 — THIS IS 4D — I VERIFY MY 271120Z — ALL BEFORE BREAK — 3C — THIS IS 4D — PRIORITY — TIME 271120Z — FROM 4D — TO — 3C — EXEMPT 40 — GROUPS 26 — BREAK — OVER

THIS IS 40 — ROGER — OUT

Emergency Silence

Emergency silence may be imposed or lifted only by competent authority. When an authentication system is in effect, the originating station must authenticate any transmission that imposes or lifts silence or is made during a

condition of silence. Silence is imposed by transmitting the proword SILENCE three times, then repeating the message. Stations do not receipt for the transmission.

RESORT PRIZE — THIS IS SABINE RAIDER — SILENCE SILENCE SILENCE — TIME 2135Z — AUTHENTICATION IS .. — I SAY AGAIN — RESORT PRIZE THIS IS SABINE RAIDER — SILENCE SILENCE SILENCE — TIME 2135Z — AUTHENTICATIONS IS ... — OUT

To lift a silence condition the NCS transmits—

PRIZE — THIS IS RAIDER — SILENCE LIFTED — TIME 2347Z — AUTHENTICATION IS ... — OUT

TACTICAL SIGNALS

The executive method of transmitting tactical signals is used when the OTC desires that all units take action at the same moment. An abbreviated plaindress format normally is used, but a time group is not included in the message ending. There are two executive methods: delayed and immediate.

Delayed Executive Method

In the delayed executive method the warning proword EXECUTE TO FOLLOW immediately precedes the text. The signal of execution is sent later in the form of "Standby — EXECUTE." At the time of execution, the signal is repeated if it is part of or one of several outstanding signals, or if a considerable time has elapsed since transmission of the EXECUTE TO FOLLOW signal. Usually only one, or just a few, stations are required to receipt for the signal of execution.

EXAMPLE 1: The signal is to be executed within a short time after sending the signal.

PRIZE — THIS IS RAIDER — EXECUTE TO FOLLOW — CORPEN PORT 185 — OVER

All stations receipt in order with ROGER — OUT

PRIZE — THIS IS RAIDER — Standby — EXECUTE (BREAK) ASHES — OVER

THIS IS ASHES — ROGER — OUT

EXAMPLE 2: Only part of an outstanding signal is to be executed.

PRIZE — THIS IS RAIDER — EXECUTE TO FOLLOW — TURN STARBOARD 080 — TACK — SPEED 25 — (BREAK) GATES — OVER

THIS IS GATES — ROGER — OUT

PRIZE — THIS IS RAIDER — TURN STARBOARD 080 — Standby — EXECUTE — LION — OVER

THIS IS LION — ROGER — OUT

When ready to execute the speed signal the OTC transmits—

PRIZE — THIS IS RAIDER — Standby — EXECUTE — (BREAK) — ASHES — OVER

THIS IS ASHES — ROGER — OUT

Immediate Executive Method

In cases of urgency the signal of execution may be transmitted as the final instructions element of the message. The warning proword is IMMEDIATE EXECUTE. This type of message does not allow stations to obtain verifications, repetitions, acknowledgements or cancelations before execution, and usually is limited to basic course and speed signals. The text is transmitted twice.

PRIZE — THIS IS RAIDER — IMMEDIATE EXECUTE (BREAK) — TURN STARBOARD 4 — TACK — SPEED 30 — I SAY AGAIN — TURN STARBOARD 4 — TACK — SPEED 30 — Standby — EXECUTE (BREAK) — ASHES — MILL — OVER

Acknowledgements

Only the commanding officer or his duly authorized representative (for example, OOD) can acknowledge a tactical signal. Although tactical radio circuits are guarded both on the bridge and in CIC, the latter cannot acknowledge unless told to do so by competent authority.

PRIZE — THIS IS RAIDER — EXECUTE TO FOLLOW — UNIFORM GOLF TWO — TACK — ONE FIVE — TACK — ZERO ZERO ZERO — TACK — ONE TWO — LION ACKNOWLEDGE — (BREAK) OVER

THIS IS LION — ROGER — OUT

After reading the decoded signal, the commanding officer of Lion directs acknowledgement:

RAIDER — THIS IS LION — WILCO (YOUR LAST TRANSMISSIONS) — OUT

RADIOTELEGRAPHY

Communications with merchant ships over very long distances is accomplished by radio transmissions that may be either manually or automatically keyed Morse telegraphy (CW), radioteletype (RATT), or other systems with an error detection and correction. Since international agreements and U.S. laws do not require ships to be fitted with the more sophisticated systems,

procedures have been developed for CW as well as INMARSAT, SITOR and RATT. The communications plan drawn up by the Naval Control of Shipping Officer may provide for the use of advanced communications systems if the ships are so fitted, in which case the procedures would closely follow the examples for CW.

Methods of Radio Communications

The principle methods of radio communication used for communicating with merchant ships in time of tension or war are the receipt method and the broadcast method.

The receipt method is the most reliable method to effect delivery of messages, as the transmitting station obtains a receipt for each message transmitted. This method has the disadvantage that the presence of both stations is disclosed and their positions can be determined by the enemy's direction finding organization. This method is therefore only used as follows:

1. For all transmissions from ship to shore, except alarm reports and distress messages. Independent ships will broadcast alarm reports and distress messages.
2. By shore stations or war vessels in the vicinity to pass instructions to independent ships which have transmitted alarm reports or distress messages. This will normally be done on an international frequency for calling, safety, or distress traffic.
3. For intership radiotelephony.

The broadcast method provides for the need for merchant ships to keep strict radio silence so they do not to disclose their positions. This method is used by the shore stations for delivering traffic to merchant ships at sea. Merchant ships do not receipt for messages.

The intercept method is a secondary method of radio communication. In this method one radio station transmits messages to another station, which will receipt for the traffic or repeat the whole transmission as received. The addressee is a third station and it does not transmit at all. The intercept method can be used between two local radio stations for transmissions to coastal convoys. In a convoy, a merchant ship will send its distress message to the convoy commodore, but the message will be intercepted by the rescue ships.

Shore-to-Ship Circuits

For shore-to-ship communication to ocean going merchant ships, the Allied Merchant Ship Communications System (MERCOMMS) is used. Centralized control of communications is necessary to ensure routing of messages to the correct broadcast station and delivery to the ship. Ships listen at scheduled times to the particular broadcast station that covers the sea area they are in, shifting to the adjacent area broadcast at prescribed SHIFT times based on a forecast of the ship's position.

Particulars of these area broadcast stations are given in allied and national publications and in Annex A to ACP 149. Where no allied merchant ship communication system has been established, national radio networks will be used. Arrangements have been made by owning nations, on a bilateral basis, for these facilities to be used by ships of other allied nations until an allied system is established.

Allied merchant ships in coastal waters receive their traffic from selected allied coast stations. These stations will transmit local warnings. Details of these stations are given in allied and national publications and in Annex A to ACP 149.

Ship-to-Shore Circuits

For ship-to-shore communication the receipt method is used for all traffic except alarm reports and distress messages. Ship-to-shore traffic is transmitted to an area or supplementary receiving station. Area and supplementary receiving stations are linked together by allied and national naval communication networks, which have outlets to other allied military and national networks. Where no allied system has been established, national ship-to-shore facilities are available the same as national broadcast facilities. Allied merchant ships in coastal waters should transmit essential messages to the nearest allied coast station.

Message Procedures

Uniformity in radio procedures will increase reliability and speed in communications and enhance security. ACP 149 prescribes procedures that will help the radio officer to achieve brevity in his communications, thereby minimizing a ship's susceptibility to enemy detection. Whenever possible, these procedures follow commercial practice so that radio officers will have little difficulty in the transition when Naval Control

of Shipping is implemented. ACP 149 should be consulted for guidance in message preparation.

ALARM REPORT

An alarm report is a message reporting the sighting of or the actual attack by hostile or suspicious forces. Any merchant ship not in a convoy that encounters a hostile force, should immediately transmit an alarm report. Unless it is transmitted as soon as suspicion is aroused, the antenna or the radio room may be put out of action before any message has been sent. The risk of making a false report must be accepted. Such reports must, however, always be canceled later if the master's first suspicions prove to be unfounded. Transmission of alarm and amplifying reports or cancellations, shall be authorized only by the master or his designated representative. Authentication, when available and made effective, is mandatory when transmitting plain language alarm and amplifying reports and cancellations.

Independent merchant vessels will broadcast the alarm report on the international distress frequency three times using full power. The nearest allied shore station, on hearing an alarm report will retransmit it, adding the date time group of receipt and the station call sign. In addition, the shore station will relay the report to the appropriate OCA for action. If no coast station is heard to repeat the alarm message, the ship will transmit the auto-alarm signal and repeat the report twice.

The most likely form of attack that is apt to occur to a ship in a convoy is by enemy submarine or aircraft. An alarm report must always be transmitted by radio if a ship in convoy sights a submarine. Silence is not to be broken until the presence of the submarine has been established with reasonable certainty.

An alarm report made by a ship in convoy is to be transmitted on the convoy radiotelephone net or on 500 KHz using low power, to notify the commodore and escort. The message is to be made once through only without the call. The commodore will receipt for it. If no receipt is received, the message is to be repeated.

Every effort should be made to inform the commodore of distress resulting from maritime causes unconnected with the enemy, by radiotelephone or visual signaling. The use of radio in such cases may disclose the presence of the convoy of which the enemy was previously unaware.

Cancellation Report

If, after sending an alarm report, the alarm should prove to be false, the report is to be canceled at once. Failure to do so may lead to unnecessary movements of the convoy and naval forces and leaves the OCA, commodore, and OTC with misleading information. The immediate cancellation of an alarm report is to be sent in plain language.

Amplification Reports

An alarm report must be followed as soon as possible by a further message or messages giving details that are likely to be of value to the OCA and to any warship coming to assist. Such messages are called amplifying reports.

Plain language amplifying reports will be made while the ship is in contact with the enemy or, if a ship has been in action, after the action is terminated.

As many plain language amplifying reports should be made as are necessary. They should contain the fullest possible description of the hostile craft so that prompt and certain action may be taken by the OCAs or by allied warships in the vicinity. The position of the ship, even though it was given in the original alarm report, should be included in the amplifying reports. The importance of ensuring that the position is accurate is emphasized. If the ship is about to be abandoned and time permits, the land for which the survivors intend to make should be reported. The nature of the damage received should be reported as accurately as possible since this report may help to evaluate the type of weapons the enemy is using.

Distress Message

In certain exceptional circumstances, the master may consider he is justified in breaking radio silence to report without delay some matter of extreme urgency, unconnected with the enemy, such as serious engine trouble, loss of propeller, running aground, fire, and so on. Distress procedure is not to be used in reporting such trouble unless the ship is in immediate danger of being abandoned. A report should be made to the OCA in an encrypted message, if time permits, and transmitted on high frequency to an allied shore station.

The distress signal is only to be used for summoning assistance in cases of great urgency

when in distress because of normal marine causes. This form of message may well bring hostile forces to the scene in the hope of sinking the transmitting ship. For this reason, do not use the distress message except when the ship is in grave peril.

In convoy, every effort should be made to inform the commodore of distress resulting from marine causes unconnected with the enemy by radiotelephone or visual signaling.

The distress message follows international format in plain language, but employs the war radio call sign or the internal convoy call sign. The use of authentication is optional.

MISCELLANEOUS REPORTS

Survivor Reports

Survivor reports are made at the discretion of the master or as ordered after having picked up survivors from a ship of which the distress is known to the OCA, OTC, or commodore. The report is made to the authority who has, or could have ordered the rescue operation. In convoy the means of communication least susceptible to interception will be used.

Weather Reports

Convoy weather reports will be transmitted only by the commodore or OTC. Special instructions governing the conditions and procedures of convoy weather reporting may be issued by the NCSO prior to sailing.

Independent ships or convoy stragglers will report weather in distress traffic when such distress is caused by adverse weather and when wind encountered are Beauford force 10 or greater.

New Position Reports

The master of an independent ship will transmit an encrypted position report whenever the actual position is more than 50 miles ahead or astern, or more than 15 miles to either side of the predetermined dead reckoning (DR) position. The DR position is based upon the planned speed of advance of the ship along the route designated in the sailing orders.

MERCHANT SHIP COMMUNICATIONS

The primary method of delivering messages from naval shore radio stations to merchant ships at sea is by a system known as Allied Merchant Ship Communications (MERCOMMS). Under the MERCOMMS system, the U.S. Navy operates a number of shore radio stations, geographically located to provide the widest possible coverage, with each station assigned an area of responsibility within which it delivers traffic by means of scheduled broadcasts. Ships copying MERCOMMS will guard the appropriate schedules when in the respective station areas of responsibility as shown in Annex B of ACP 149 and as directed by sailing or diversion orders issued by competent authority. The MERCOMMS is a broadcast concept under which no acknowledgement from the ships addressed is required or desired.

Upon the declaration of a state of emergency or the commencement of hostilities, all U.S. flag merchant ships will begin to copy the appropriate MERCOMMS area broadcast. Details of schedules, frequencies, and modes of emission of coast stations are obtained from up to date international and national publications; for example, list of coast stations.

MERWARN MESSAGES

In the event of a nuclear attack or threatened nuclear attack, nuclear fallout warnings to merchant ships (MERWARN) will be broadcast by allied coastal radio and area broadcast stations when merchant ships risk receiving radioactive fallout. These warnings will be either a PREBURST message or a FALLOUT Message.

A MERWARN PREBURST message is a prediction of likely fallout data for nuclear bursts and is valid over a specific area for a specific period. This information will allow the master of a merchant ship at sea, upon observing a nuclear detonation, to plot immediately the likely pattern of the explosion.

A MERWARN FALLOUT message is an after the fact (post burst) prediction of the sea

areas affected by fallout as the result of a nuclear weapon detonation or a general nuclear attack, for a specific period. The purpose is to inform masters of merchant ships at sea of the actual sea areas rendered dangerous because of nuclear bursts.

Details of MERWARN messages are contained in DMA PUB 117, chapter 10.

THE NAVAL MESSAGE

Many of the messages received by a merchant ship via MERCAST during times of war or national emergency will be sent by naval authorities using the standard Navy message format, which differs from commercial messages. The following information is presented to acquaint the merchant officer with the naval message.

PRECEDENCE

A messages's precedence indicates the originator's desired writer-to-reader delivery time. It indicates to communication personnel the relative order of processing and delivery, and to the addressee the relative order in which the message should be noted. Precedence has no relation to the time that any reply must be sent or to the precedence of such reply.

Assigning precedence is the drafter's responsibility although the releaser may change the assignment. The importance of the subject matter does not necessarily determine precedence.

There are five precedence categories. Table 15-5 lists the four categories commonly used, together with example (not all-inclusive) of their assignments and speed-of-service objectives.

The fifth precedence category is limited to use by the National Command Authority and certain unified and specified commands for specifically designated emergencies. Called the Emergency Command Precedence (prosign Y), it provides a Flash preempt capability.

DATE/TIME GROUP

Messages are assigned a date/time group (DTG) for identification purposes only. The DTG consists of six numerals and a time zone suffix. The first two digits represent the day of the month; the second two, the hour; and the final pair, the minutes. The time zone suffix normally used is that for Greenwich mean time (Ƶ). The DTG is followed by the abbreviated month and year. Thus, Ø414ØØZ JUL 76 identifies a message released for transmission at 1400 (GMT) on 4 July 1976.

TYPES OF MESSAGES

Most messages have at least one addressee who is responsible for taking action and for originating any necessary reply. Other addressees who may be concerned with the message, but who do not have primary responsibility for taking action, receive the message for information.

There are four types of narrative messages: single-address, multiple-address, book, and general.

SINGLE-ADDRESS

This message, as its name implies, is destined for only one addressee. The addressee may be designated as either an action or information addressee.

MULTIPLE-ADDRESS

A multiple-address message is one destined for two or more addressees, each of whom must be informed of all the other addressees. In the event numerous transmissions are required to effect delivery, each transmission must contain all the addressees.

In most cases, a few addressees are designated as action and a few as information addressees. There may be situations when all addressees are designated action and still other times when all may be information.

Multiple address messages having both action and information addressees may either be assigned a single precedence for all addressees, or they may be assigned two precedences, one for all action addressees and a lower precedence for all information addressees. Employment of dual precedence must be considered for all messages with an information addressee when other than Routine precedence is assigned to the action addressee(s).

In the interest of circuit efficiency, the number of addressees per message must be kept to the barest minimum—those commands with a "need-to-know." The originator should also consider the necessity of each addressee knowing the other addressees. If there is no "need-to-know," a book message should be used.

PROSIGN	DESIGNATION	DEFINITION AND USE	HANDLING REQUIREMENTS
Z	FLASH	FLASH precedence is reserved for initial enemy contact messages or operational combat messages of extreme urgency. Brevity is mandatory. Examples: (1) Initial enemy contact reports. (2) Messages recalling or diverting friendly aircraft about to bomb targets unexpectedly occupied by friendly forces; or messages taking emergency action to prevent conflict between friendly forces. (3) Warnings of imminent large-scale attacks. (4) Extremely urgent intelligence messages. (5) Messages containing major strategic decisions of great urgency. (6) Tropical storms, typhoons, or hurricanes believed to be previously undetected. Unit commanders may use Flash procedure for reporting, provided there are no extenuating circumstances that would jeopardize the tactical situation	FLASH messages are hand-carried, processed, transmitted, and delivered in the order received and ahead of all other messages. Messages of lower precedence will be interrupted on all circuits involved until handling of the FLASH message is completed. Time Standard: As fast as possible with an objective of less than 10 minutes.
O	IMMEDIATE	IMMEDIATE is the precedence reserved for messages relating to situations that gravely affect the national forces or populace, and require immediate delivery to the addressee(s). Examples: (1) Amplifying reports of initial enemy contact. (2) Reports of unusual major movements of military forces of foreign powers in time of peace or strained relations. (3) Messages that report enemy counterattack or request or cancel additional support. (4) Attack orders to commit a force in reserve without delay. (5) Messages concerning logistical support of special weapons when essential to sustain operations. (6) Reports of widespread civil disturbance. (7) Reports or warnings of grave natural disaster (earthquake, flood, storm, etc.). (8) Requests for or directions concerning distress assistance. (9) Urgent intelligence messages. (10) Requests for news of aircraft in flight, flight plans, or cancellation messages to prevent unnecessary search/rescue action. (11) Weather observations with wind speed 34 knots or greater.	IMMEDIATE messages are processed, transmitted, and delivered in the order received and ahead of all messages of lower precedence. If possible, messages of lower precedence will be interrupted on all circuits involved until the handling of the IMMEDIATE message is completed. Time Standard: 30 minutes.

Table 15-5.—Precedence of Messages—Continued

PROSIGN	DESIGNATION	DEFINITION AND USE	HANDLING REQUIREMENTS
P	PRIORITY	PRIORITY is the precedence reserved for messages that furnish essential information for the conduct of operations in progress. This is normally the highest precedence for administrative messages. Examples: (1) Situation reports on position of front where attack is impending or where fire or air support will soon be placed. (2) Orders to aircraft formations or units to coincide with ground or naval operations. (3) Messages concerning imminent movement of naval, air, or ground forces (4) Administrative, logistical, and personnel matters of an urgent and time sensitive nature. No higher than Priority precedence will be assigned to administrative messages except those reporting death, serious illness, or serious injury, which may be assigned Immediate precedence. (5) Weather observations with surface wind speeds 33 knots or less and all oceanographic observations.	PRIORITY messages are processed, transmitted, and delivered in the order received and ahead of all messages of ROUTINE precedence. ROUTINE messages being transmitted should not be interrupted unless they are extra long and a very substantial portion remains to be transmitted. PRIORITY messages should be delivered immediately upon receipt at the addressee destination. When commercial refile is required, the commercial precedence that most nearly corresponds to PRIORITY is used. Time Standard: 3 hours.
R	ROUTINE	ROUTINE is the precedence to use for all types of messages that justify transmission by rapid means unless of sufficient urgency to require a higher precedence. Examples: (1) Messages concerning normal peacetime military operations, programs, and projects. (2) Messages concerning stabilized tactical operations. (3) Operational plans concerning projected operations. (4) Periodic or consolidated intelligence reports. (5) Ship movement messages, except when time factors dictate use of a higher precedence. (6) Supply and equipment requisition except when time factors dictate use of a higher precedence. (7) Administrative, logistic, and personnel matters.	ROUTINE messages are processed, transmitted, and delivered in the order received and after all messages of a higher precedence. When commercial refile is required, the lowest commercial precedence is used. ROUTINE messages received during nonduty hours at the addressee destination may be held for morning delivery unless specifically prohibited by the command concerned. Time Standard: 6 hours.

BOOK MESSAGE

A book message is one destined for two or more addressees, but the originator considers it to be of such nature that no addressee needs to know the other addressees.

The operating signal ZYQ is placed conspicuously on the face of the message to indicate that the message must be handled as a book message. The operating signal ZEX indicates that a message may, but need not be, handled as a book message.

GENERAL MESSAGE

A general message provides a standard distribution to a large group of addressees, as in a particular area, fleet, or operation. Each general message has a title (for example, ALCOM) that serves as the address because it indicates the distribution. All commands to whom general messages are addressed are considered to be action addressees. It is the command's responsibility to determine what action, if any, need be taken.

MESSAGE COMPONENTS

With a few exceptions, military messages are arranged according to a standard form. Called basic message format, it stays substantially the same for all methods of transmission.

The message format is divided into three parts: heading, text, and ending. Each part contains various components and elements arranged according to the 16 format lines. The format lines place message contents in a standard sequential order, but whether each line is used depends on such factors as the type of message and the method of transmission.

Table 15-6 contains the message format for radiotelegraph usage, which is essentially the same as that for radioteletype (RATT). We will not discuss the format in detail as the table is generally self-explanatory. Clarifying information is provided, however, for certain elements.

HEADING

Of the three message parts, the heading is the most complex. As shown in table 15-6, it has 4 components, 10 elements, and 10 of the 16 format lines.

Format line 1 is called handling or routing instructions and is used only in tape relay and automatic digital networks.

If there are both action and information addressees, the preamble (line 5) might contain a dual precedence. The highest precedence will be for the action addressees; the lowest, for the information addressees.

The operating signals mentioned in the preamble are used only when necessary to indicate special handling or delivery instructions. For example, the originating communications center might send ZFG after the DTG in a RATT or CW message. This would indicate that the message is an exact duplicate of a message previously transmitted. Or, an originating station might send the prosign IX after the DTG in a CW message, which would have the same meaning as the proword EXECUTE TO FOLLOW in the preamble of a message sent by radiotelephone.

In the prefix (line 10), the accounting information, which consists of the prosign ACCT and a combination of letters and numbers, called the accounting symbol and program designator code (PDC), are used to establish accountability for charges incurred when messages require transmission entirely or partially via domestic or international commercial communications systems. Accounting symbols and PDCs are assigned to most of the authorized users of U.S. military communications facilities. The two-character accounting symbols are suffixed with four character PDCs for user identification.

Each message requiring commercial refile transmitted by a military communications center to the commercial refile center, must have a line 10 that contains the accounting symbol prosign "ACCT" followed by a space and the appropriate accounting symbol, when applicable, the group count prosign "GR" and a group count, a dash (-) and the appropriate PDC.

Examples:

ACCT NA GR123-CNRF

ACCT NA-CNRF

The accounting symbol and PDC shown in the examples are the ones that are used by all Navy commands and activities.

The group count prosign and group count shall be used only when the text consists of countable encrypted groups. The PDC must be preceded by a dash (-) following the accounting symbol or group count.

Parts	Components	Elements	Format line	Contents
HEADING	Beginning procedure	Handling instructions	1	Not used in radiotelephone and radiotelegraph.
		a. Call	2	Station(s) called; prosign XMT(exempt) and exempted calls.
			3	Prosign DE (from) and designation of station calling.
		b. Transmission identification c. Transmission instructions	4	Station serial number. Prosign T(relay); G (repeat this transmission back to me exactly as received); F (do not answer); operating signals; call signs, address groups, plain language.
	Preamble	a. Precedence; date-time group; message instructions	5	Precedence prosign; date-time group and zone suffix; operating signals; prosign $\overline{\text{IX}}$ (execute to follow).
	Address	a. Originator's sign; originator	6	Prosign FM (originator of this message is); originator's designation expressed as call sign, address group, or plain language.
		b. Action addressee sign; action addressee(s)	7	Prosign TO; action addressee designation(s) expressed as call signs, address groups, address indicating groups, or plain language.
		c. Information addressee sign; information addressee	8	Prosign INFO (this message addressed for information to); information addressee designation(s) expressed as call signs, address groups, or plain language.
		d. Exempted addressee sign; exempted addressee(s)	9	Prosign XMT; exempted addressee designation(s) expressed as call signs, address groups, or plain language.
	Prefix	a. Accounting information; group count; program designator code	10	Accounting symbols prosign ACCT, accounting symbol, group count prosign GR, group count, dash (-) PDC.
SEPARATION			11	Prosign $\overline{\text{BT}}$ (break).
TEXT	Text	a. Subject matter	12	Internal instructions; basic idea of originator.
SEPARATION			13	Prosign $\overline{\text{BT}}$.
ENDING	Ending procedure	a. Time group	14	Hours and minutes expressed in digits and zone suffix, when appropriate.
		b. Final instructions	15	Prosigns B (more to follow); $\overline{\text{AS}}$ (I must pause); C (I am about to correct a transmission error in some foregoing part of this message); operating signals.
		c. Ending sign	16	Prosign K (go ahead and transmit), or $\overline{\text{AR}}$ (end of transmission).

TEXT

Format line 12 contains the entire text of a message. The contents are arranged in a standard sequence. All messages, however, do not necessarily contain all the elements of our discussion. In such cases the nonessential elements are simply omitted.

(Some messages, such as short one- or two-line messages, tactical messages, contact and amplifying reports, casualty reports, logistic requests, and so on, are exempt from using this form. These "proforma" messages have a firmly established format using letters or numbers that have a prearranged meaning.)

Classification Line

The first line of the text contains its classification and, as required, special handling instructions, code or flag words, and the Standard Subject Identification Code.

CLASSIFICATION.—The first word of the classification line is the classification of the message or the word UNCLAS if the message is unclassified. Categories are Top Secret, Secret, and Confidential. Two other designations, while not classifications in themselves, may be used. Their descriptions follow.

Unclassified information that should not be given general circulation or released publicly is marked FOUO (for official use only). Two examples of FOUO are inspection reports and personnel record information. This would appear in the message as UNCLAS FOUO.

Messages that require special handling but do not meet critera for a security classification are marked EFTO (encrypt for transmission only). The message classification line would read UNCLAS E F T O. The EFTO marking is not required in the classification line of unclassified messages addressed exclusively among Navy and Marine Corps commands. The only time EFTO markings are required is when Navy and Marine Corps unclassified messages are marked FOUO and are addressed to a DOD activity outside the continental U.S. (CONUS) and not part of the Navy and Marine Corps. The classification line of these messages will read: "UNCLAS E F T O FOUO." FOUO messages transmitted outside CONUS on foreign circuitry, and those addressed to non-DOD agencies will not be handled EFTO.

Fleet Commanders in Chief are authorized to lift EFTO FOUO procedures when operational necessity dictates.

SPECIAL HANDLING.—Some classified messages require special handling in addition to that required by the security classification. The special handling designator is placed in the classification line immediately following the classification. Some examples are—

SPECAT (special category). Used in conjunction with code words or to specify delivery only to a named individual (SPECAT EXCLUSIVE FOR). The latter category has several restrictions on its use (for highly sensitive matter, for use only by flag officers, or officers in command status).

LIMDIS (limited distribution). Subject matter requires limited distribution within the addressed activity. Only classified messages qualify for LIMDIS markings.

PERSONAL FOR. Only flag officers and officers in command status may originate this type of message, but it need not be classified.

NOFORN (no foreign dissemination). May be applied only to intelligence and Navy nuclear propulsion information, and crypto, transmission, and emission security systems.

NAVY EYES ONLY. For messages warranting prevention of access by personnel of the other military services.

CODE OR FLAG WORDS.—Code words, flag words, and names or nicknames of exercises, projects or operations indicate some form of special handling or internal routing requirements. When used they immediately follow the security classification or special handling designators, if used. These code words or names are prepared with normal spacing; for example, PROJECT HOT HOUSE.

STANDARD SUBJECT IDENTIFICATION CODE (SSIC).—With the advent of automated message processing in the fleet and ashore, methods and procedures are needed to realize the full saving of personnel and time. Basic to operation of these processors are means whereby relatively simple computer programs can determine the general subject matter of messages and, from this, the internal distribution to be given messages.

The SSIC consists of an appropriate five-number group (obtained from the Department of

the Navy Standard Subject Identification Codes, SECNAVINST 5210.11) preceded by the letter N. The letter N carries no other connotation than to indicate that the numeric group was taken from a Navy source. Those codes that contain only four numbers are preceded by a zero to maintain the number of characters in the SSIC constant.

The responsibility for assigning the SSIC rests with the message drafter. The code is placed in the message text on the same line and immediately following the security classification and special handling instructions. For example, UNCLAS EFTO //NØ23ØØ//. The drafter of a message must realize that internal distribution of a message can and most probably will be affected on the basis of the assigned SSIC. Therefore, common sense and good judgment should be applied when determining and assigning the code.

The standard subject identification code is placed on all messages except—

1. Tactical messages handled exclusively on tactical circuits.
2. Messages using code or flag words exclusively to identify the subject matter. Exercise messages fall within this category. For example, Operation SCARLET TOWER or Exercise HIGH HEELS.
3. Messages transmitted on dedicated or closed networks and remaining within the network. For example, weather networks, and operational control center networks.
4. CASREP/MOVREP/UNITREP messages and messages containing the Navy's portion of the Joint Reporting System (JRS). All other proforma messages will include the SSIC.
5. Messages addressed only to commercial firms or individuals via commercial refile.

Messages containing special handling markings and service messages are assigned the SSIC //N00000//, as are emergency messages if determining the proper SSIC will delay the message.

Passing Instructions

Passing instructions placed in the second line of the text (below the classification line) consisting of office codes/symbols/names are NOT authorized for NAVY/MARINE CORPS/COGARD activities except as follows:

1. Messages addressed to non-NAVY/MARINE CORPS/COGUARD activities (for example, U.S. ARMY, U.S. AIR FORCE, DOD), that do not contain office symbols.
2. By a headquarters staff passing a message to a temporarily relocated commander.

Examples are cited below:

"CINCUSAREUR FOR SARME—CE" or

"CINCLANT FOR ADM SMITH"

Subject Line

The subject line begins at the left-hand margin of the first line following the classification line (or following the passing instructions when authorized for use). It will always begin with the abbreviation "SUBJ."

Message subject lines are keys to the reader as to the basic contents of the message text. Concurrently, internal message routers and Navy automated message processing systems key on the subject line to determine internal message distribution. Therefore, messages containing similar information should be assigned a standard subject whenever practicable to facilitate message identification and internal distribution.

The text of the subject line may be omitted when its use will cause an otherwise unclassified message to be classified, its use will noticeably increase the length of short messages or if the message subject is readily apparent in the first line of text, or if the message is tactical in nature and proforma (for example, CASREP, EMPSKED, MOVREP). However, the abbreviation "SUBJ" will be inserted at the left-hand margin in the textual sequence with the remainder of the line left blank.

References

Reference lines are used as an alternative to repeating lengthy references within the text of a message. Each reference is lettered consecutively. Any document, message, or telephone conversation may be referenced, provided the reference line is sufficiently specific.

A reference consists of the short title of the command originating the message, followed by the date time group of that message, for example,

A. CNO WASHINGTON DC 122132Z SEP 84.

References that are not addressed to all addressees must bear an indication of that fact.

A reference that is "not to or needed by all" is suffixed by the abbreviation NOTAL. A reference that is "not to all, but is needed and is being passed separately" is suffixed by the abbreviation PASEP. If there is no indication after the DTG, month, and year, it is understood that all addressees have the reference.

Text

The need for brevity is stressed, but not to the point where a loss of clarity will arise. Abbreviations and short titles should be used to shorten the text, thereby saving transmission time. Abbreviations and short titles, however, should be limited to those common to a particular field or branch of service.

Punctuation in messages is not used unless it is necessary to the sense of the message. A list of authorized punctuation, abbreviations, and symbols is contained in the effective edition of NTP 3.

The basic thought is arranged in a form similar to the rules for outlining procedures. Each paragraph is identified by a number (single-paragraph messages need not be numbered). Each subparagraph is indented and identified by a letter. Each sub-subparagraph is further indented and identified by a number enclosed in parentheses.

Each paragraph and subparagraph of a classified message bears a letter indicating the classification of that particular paragraph. The letter used to indicate the classification is the first letter of the appropriate security classification, enclosed in parentheses. The letter indicating the classification immediately follows the identifying number of each paragraph.

NOTE: No paragraph may be classified higher than the classification of the message.

Single-paragraph messages do not have to be marked for classification.

If Restricted Data or Formerly Restricted Data information is included in the text, each paragraph must be so marked. A Secret paragraph containing Restricted Data is marked (SRD); one containing Formerly Restricted Data is marked (SFRD). Paragraphs with NOFORN information are similarly marked (NOFORN).

Downgrading and Declassification

Downgrading and declassification markings must be applied to all classified messages (except those addressed only to foreign addressees). They are placed at the left margin on the first line after the last line of text: Examples:

DECL ____________________ See Note 1

DECL OADR ____________ See Note 2

DG/_______/ ____________ See Note 3

Notes:

1. Insert day, month, and year for classification, for example, 6 Mar 99.
2. Used when downgrading and classification unknown.
3. Insert "S" or "C" and specific date of event, for example, DG/C/6 APR 93.

Message containing restricted data or formerly restricted data do not require an indication of downgrading or declassification; however, the originator's record copy shall indicate the basis of classification.

General information on the downgrading and declassification system is contained in OPNAVINST 5510.1, Department of the Navy information security program regulation.

ENDING

The ending, lines 14 through 16, usually is employed only over radiotelephone and CW circuits. Even then, every line is not necessarily used.

Format line 15 contains the final instructions. The operator may use this line to correct transmission errors, indicate a pause, execute a message, or indicate more traffic for a specific station by the use of prosigns, operating signals, and station designators as required.

Format line 16 is the ending sign. For voice and CW transmission, this is proword/prosign OVER(K) or OUT(AR) as appropriate. This format line is used merely to indicate the end of transmission.

Figure 15-12 illustrates message style and paragraph marking, and summarizes the explanations of various message components. Figure 15-13 is a general message from the Secretary of the Navy to the entire naval establishment, including the Marine Corps.

MINIMIZE

In an emergency, military telecommunications systems usually become severely overloaded; it is

UNCLASSIFIED EXAMPLE

PR 261743Z JUL 84
FM COMNAVTELCOM WASHINGTON DC
TO CNO WASHINGTON DC
AIG SIX FOUR
INFO COMDESRON TWENTY
USS ENTERPRISE
ZEN/USS DIXIE
XMT USS KNOX
BT
CONFIDENTIAL NOFORN //NØ23ØØ//
SUBJ: PROPER MESSAGE WRITING (U)
A. CNO WASHINGTON DC 131826Z MAY 84 NOTAL
B. COMCRUDESGRU TWO 1Ø2315Z JUN 84 PASEP
1. (C) THE LETTERS PR AT THE TOP OF THE MESSAGE ASSIGNS A PRECEDENCE OF PRIORITY TO THE ACTION ADDRESSEES AND A PRECEDENCE OF ROUTINE TO THE INFORMATION ADDRESSEES.
2. (U) THE OPERATING SIGNAL ZEN INDICATES THE MESSAGE HAS BEEN DELIVERED BY OTHER MEANS.
3. (U) THE PROSIGN XMT INDICATES THE ADDRESSEE IS EXEMPTED FROM RECEIVING THE MESSAGE.
4. (C) REFERECNE A USES THE ACRONYM NOTAL (NOT TO ALL) TO REFERENCE A MESSAGE NOT HELD BY ALL ADDRESSEES.
5. (C) REFERENCE B USES THE ACRONYM PASEP TO INDICATE THAT NOT ALL ADDRESSEES HAVE THIS REFERENCE BUT THAT IT IS NEEDED AND WILL BE PASSED SEPARATELY.
6. (U) IN ACCORDANCE WITH THE NAVY SECURITY MANUAL THIS MESSAGE IS DECLASSIFIED ON 26 JULY 1990.
DECL 26 JUL 90
BT

Figure 15-12.—Unclassified example of message construction.

R Ø11624Z MAR 84
FM SECNAV WASHINGTON DC
TO ALNAV
BT
UNCLAS //NØ3573// SECNAVNOTE 3573
ALNAV Ø16/84
SUBJ: SHIP'S LANDING PARTIES/LANDING PARTY MANUAL
A. OPNAV P34-Ø3 (LANDING PARTY MANUAL)
1. THE PROVISIONS OF REFERENCE A WHICH REQUIRE THE ORGANIZATION AND MAINTENANCE OF SHIP'S LANDINGPARTIES ARE HEREIN CANCELLED.
2. WITH THE EXCEPTION OF DRILLS AND CEREMONIES, AND INTERIOR GUARD, ALL OTHER SUBJECT MATTER NOW CONTAINED IN REFERENCE A IS ADDRESSED IN OTHER NAVY, MARINE CORPS, OR JOINT PUBLICATIONS. ACCORDINGLY, UPON PUBLICATION BY THE MARINE CORPS OF NEW MANUALS ON DRILL AND CEREMONIES, AND INTERIOR GUARD, REFERENCE A IN ITS ENTIRETY WILL BE CANCELLED.
BT

then necessary to reduce voice and record traffic so that essential traffic may be efficiently handled. The Minimize condition accomplishes this reduction by imposing the requirement to clear military circuits of nonessential traffic.

CNO, fleet commanders in chief, and area coordinators may impose Minimize on users of Navy communications systems; subordinate commanders may impose Minimize over elements of their commands only with prior permission from one of the foregoing. Messages originated by the JCS or unified/specified commanders imposing Minimize are applicable to Navy and Marine Corps commands located in the geographical area in which imposed.

During Minimize the length of Flash messages should not exceed 100 words; those of Immediate precedence should not exceed 200 words. Only essential traffic will be transmitted, essential traffic being that of any precedence that must be transmitted electrically to avoid a serious detrimental impact on mission accomplishment or safety of life. Some types of environmental data fall within this criteria. These types include but are not limited to—

1. Warnings, Advisories, and Forecasts:

- Smallcraft/thunderstorm/gale/storm/hurricane/typhoon and high seas warnings

- Tropical disturbance advisories

- Weather en route forecast (WEAX) messages as dictated by weather conditions and operations

- Optimum track ship routing (OTSR) messages

- ASW forecasts dictated by the operational situation

- Ice forecasts dictated by the operational situation

- RADO when DEFCON 1 or 2 is set

2. Weather and Oceanographic Observations When Observed Parameter Reflects Significant Weather:

- All normal 6-hour synoptic weather observations

- Oceanographic observations as dictated by the operational situation

- In general, routine area forecasts do not meet criteria for transmission during MINIMIZE unless conditions prevail where an area forecast could indirectly have a serious detrimental impact on mission

The following supply data pattern traffic is permitted during MINIMIZE.

- MILSTRIP requisitions, referrals, supply directives, passing orders relating to material CASREP classified as C2 or greater

- MILSTRIP issue group 1 and 2 follow-ups, status, modifiers, cancellations

- MILSTRAP documents that effect on-hand balances

- MILSTAMP transportation priorities 1 and 2 documents

- MILSCAP alert and acceptance documents involving dealer discounts

- MILSCAP issue priority groups 1 and 2 related contract modifications, accelerated delivery requests, and shipment performances

- Financial documents determined by originator to have a precedence of PRIORITY or higher

- Documents for part number screening related to MILSTRIP requisitions

COMMUNICATIONS SECURITY

The security of naval operations depends, in part, upon successfully safeguarding classified information. Comprehensive security programs are designed to achieve that end. The security program as a whole, however, is beyond the scope of this chapter. Our interest lies in communications security, and within that category, to transmission security in particular.

Communications security (COMSEC) is the protection resulting from all measures designed to deny unauthorized persons information of value that might be derived from the possession and study of telecommunications. Included are

efforts to mislead unauthorized persons in their interpretation of whatever information they may have acquired. COMSEC includes: (1) physical security, (2) emission security, (3) cryptosecurity, and (4) transmission security of COMSEC material and information.

PHYSICAL SECURITY

Physical security deals with safeguarding classified equipment, material, and documents by physical means. It includes security areas and the stowage, custody, accountability, dissemination, and ultimate disposition of classified matter. Simply put, it means preventing unauthorized persons from viewing or gaining possession of classified matter.

EMISSION SECURITY

Emission security is that which results from measures taken to deny unauthorized persons information of value that might be derived from intercept analysis of emanations from telecommunications systems.

CRYPTOSECURITY

Cryptosecurity is the component of COMSEC, which results from the provision of technically sound cryptosystems and their proper use.

Cryptography deals with the processes, method, or means of preparing messages or writings that are intended to be incomprehensible except to those who possess the proper special paraphernalia and knowledge to use them to reproduce the original plain text of the messages or writings. Usually these processes are accomplished by means of cryptosystems employing codes or ciphers.

Code Systems

Basically, a code system is a type of substitution in which the textual units (words, phrases, or sentences) are substituted for by designated groups of letters, numbers, or combinations of letters and numbers. Normally, these designated groups of letters, numbers, or combinations thereof, with their associated meanings, are printed in booklet form and are carried by all authorized users of that particular code. Most codes in use by the Navy (for example, operations codes, numeral codes, and authentication codes) are designed primarily for ease of use; they do not provide long-term security. Therefore, messages containing long-range planning should not be encrypted in these codes.

Cipher Systems

In a cipher system, a letter, number, or symbol is substituted for each letter of the message being enciphered. The majority of cipher systems in use within the Navy are machine-supported; that is, having either electromechanical or substitution. Paper and pencil systems, used with one-time pads, are in use but to a much lesser degree because of their extremely slow processing speed. If used properly, the cipher system provides excellent long-term security for the information encrypted therein. A cipher system, with its associated items of cryptomaterial and ancillary equipments, makes up a cryptosystem.

TRANSMISSION SECURITY

Transmission security is that component of communication security resulting from all measures to protect transmission from interception and exploitation by means other than cryptoanalysis.

Some methods of transmission are more secure than others. In general, the means and types of transmission, in their order of security, are as follows:

1. Messenger
2. Registered mail (guard mail, U.S. postal system, or diplomatic pouch)
3. Approved wire circuits
4. Ordinary mail
5. Nonapproved wire circuits
6. Visual (semaphore, flaghoist, flashing light)
7. Sound systems (whistles, sirens, bells)
8. Radio

Additional information on transmission security for those types of transmissions used by merchant ships is presented below.

Visual Communications

Visual communication systems are used in preference to radio, except at night, when there is a possibility of divulging a ship's position. They are more secure than radio because reception is limited to units in the immediate vicinity of the sender.

In order of security, visual communication methods rank according to the distance from which signals can be seen. In daylight the relative order is semaphore, directional flashing light, panels, flaghoist, pyrotechnics, and nondirectional flashing light.

Utmost care must be taken to ensure that signal lights are used only when necessary and that minimum light is employed. An exception is for recognition signals, which must be sent on a light sufficiently brilliant to be seen.

Transmission of plain language messages is kept to a minimum because many persons are adept at reading lights and flags.

Sound Systems

Whistles, sirens, foghorns, bells, and underwater sound devices are common types of sound systems. They are used by vessels to transmit emergency warning signals (air raid alerts, mine sighting, and so on) and for signals prescribed by the rules of the road. Their use, for the most part, is restricted to maneuvering and to emergency situations.

Radio

Radio is potentially the least secure means of communication. A message sent by radio is open to interception by anyone who has the necessary equipment and is within reception range. Thus, in addition to obtaining intelligence, an enemy may be able to fix the location of operating forces by means of direction finding. By employing deceptive techniques, the enemy could confuse and hamper our communications and, by traffic analysis, forecast the intentions of our forces.

Uses of radio in the ultrahigh frequency (UHF), superhigh frequency (SHF), and extremely high frequency (EHF) ranges, normally have security approaching visual means. Experience has proven, however, that transmissions of these frequencies beyond line-of-sight distances have occurred frequently. It is important, therefore, that all users recognize the possibility of interception at distances far beyond the normal usable ranges.

Despite its shortcomings, radio still is the primary means of communication. It is fast, reliable, and often the only method of maintaining contact between distant and highly mobile units. The degree of security has been improved through the use of on-line cryptographic systems, but radio is still subject to jamming, interference, and direction finding.

The following five topics describe the ways by which radio communications may be sabotaged by an enemy, and countermeasures that may be applied.

INTERCEPTION AND DIRECTION FINDING.—Strict radio silence is the best defense against enemy intelligence efforts by interception and direction finding. It is apparent that an enemy cannot gain intelligence from radio transmissions if none are sent. Radio silence is placed in effect when it is reasonable to assume that an enemy is unaware of the location or impending movements of a ship or force. If it is impracticable to maintain radio silence, the following defensive measures make interception and direction finding more difficult.

1. Avoid unauthorized transmission and unnecessary testing.
2. Use combinations of transmitters, antennas, and power to produce minimum wave propagation and emission intensity consistent with reliable communications.
3. Use the broadcast method of transmitting traffic in preference to the receipt method.
4. Conceal instructions to shift frequency by using an encrypted message in the absence of a prearranged plan.
5. Adjust transmitters accurately and adhere to frequency tolerances, thereby preventing the need for repeating messages or parts of messages.
6. Maintain strict circuit discipline.

TRAFFIC ANALYSIS.—By traffic analysis an enemy may gain valuable information from the study of communications. Traffic analysis includes studying message headings, receipts, acknowledgements, relays, routing instructions, and service messages; tabulating the volume, types, and directional flow at each point; and correlating information taken from unclassified messages, noting departures from normality.

Assume that within a short time a radio message is transmitted from point Bravo to Romeo, another to Victor, another to a unit of the fleet operating off point Whiskey, and a fourth to a unit off Oscar. Enemy traffic records show that messages rarely are transmitted to these four addressees simultaneously. They also reveal that previous transmissions of this type were followed by arrival of a convoy at point Romeo. An enemy logically may conclude that a convoy from Bravo to Romeo is planned, and that these transmissions probably are arranging for an escort.

Some measures that can be taken to render traffic analysis by an enemy more difficult and less reliable include—

1. Minimum use of radio
2. Maintenance of strict circuit discipline
3. Rotation of frequencies
4. Rotation of call signs and address groups for encryption
5. Minimum use of service messages, correction requests, and repetitions
6. Concealment of originator and addresses in the text of an encrypted message
7. Avoidance of long, easily associated messages of a recurrent nature
8. Control of the timing and volume of test transmissions to avoid revealing information about pending operations
9. Keeping external routing instructions to a minimum
10. Use of encrypt for transmission only (EFTO) procedure

IMITATIVE DECEPTION.—An enemy may attempt to enter communication nets used by the Navy to confuse and deceive U.S. forces. This practice is known as imitative deception. There are many deceptive techniques an enemy might use to obstruct radio communications. The enemy may, for example—

1. Receive a message from one circuit and introduce it on another circuit to waste time and create confusion.

2. Intentionally garble the text of a genuine message and combine it with the heading of another, then introduce it on a different radio net.

3. Originate and transmit false plain language messages.

4. Call a unit in the hope of taking bearings on the answering transmission.

5. Partly obliterate a false message to conceal lack of knowledge of authenticators or call signs.

Proper authentication is the best defense against imitative deception. This security measure is intended to protect communication systems against fraudulent transmissions. An authenticator is a group of characters (such as two randomly selected letters) inserted in a message to prove its authenticity. Any authentication system has accompanying instructions specifying the method of use and transmission procedures. By its correct use, an operator can distinguish between genuine and fraudulent stations or transmissions. A station may include authentication in a transmitted message. This security measure is called transmission authentication.

Authentication is mandatory when—

1. Suspecting imitative deception on a circuit.

2. Challenging or requesting any station to authenticate.

3. Directing radio silence or requiring a station to break an imposed radio silence.

4. Transmitting a plain language cancellation or an ecrypted message by radio or by other methods when sending stations cannot be recognized.

5. Transmitting to a station that is under radio silence.

6. Making contact and amplifying reports in plain language or brevity code.

7. Transmitting operating instructions affecting the military situation; for example, closing down a station or shifting frquency.

8. Making initial radio contact or resuming contact after prolonged interruption. Authentication should be exchanged to prevent an unauthorized station from opening a circuit by asking a legitimate station to authenticate.

9. A station failing, for any reason, to obtain an answer to its calls is forced to transmit its messages blind, that is, without getting a receipt from the intended receiving station.

10. When authorized to transmit a classified message in the clear over a nonapproved circuit.

Maintaining a high degree of circuit discipline on the part of operators also lessens chances of enemy deception. Circuit discipline can be attained only through net control, monitoring, and training. It includes adherence to prescribed frequencies and operating procedure. Negligence, inaccuracy, and laxity—as well as lack of circuit discipline and operator training—are some of the common causes of violations that endanger radio transmission security.

JAMMING—Jamming is another method used by an enemy to disrupt communications. It is accomplished by transmitting a strong signal on the victim frequency. An operator must be able to recognize jamming, cope with it, and simultaneously prevent an enemy from knowing

how effective the jamming has been. Common forms of jamming are—

1. Several carriers adjusted to the victim frquency, each carrier modulated by an audiofrequency.

2. Simulated traffic handling on the victim frequency.

3. Random noise amplitude-modulated carriers.

4. Continous-wave carrier (keyed or steady).

5. Several audio tones in rapid sequence, modulating a carrier (called bagpipe, from its characteristic sound).

6. Electrical spark, consisting of numerous jagged peaks of noise of short duration, and having high intensity and high repetition rate. Spark jamming is encountered more frequently than any other type because it is fairly easy to generate, and its radiofrequency characteristics enable an enemy to cover a number of communication channels with one jammer.

SECURITY OF RADIOTELEPHONE.— Radiotelephone transmissions are the least secure method of radio communication. Anyone within range who speaks the language used can understand the transmission. Circuit discipline and procedure often are poor on radiotelephone circuits because the equipment can be, and often is, operated by someone besides trained radio personnel. Poor circuit discipline and improper procedure slow communications, cause confusion, and may divulge information to an enemy.

Probably the best defense against enemy intelligence efforts is strict adherence to prescribed radiotelephone procedures. A few precautions to observe when communicating by radiotelephone are as follows:

1. Use each circuit for its intended purpose only.
2. Keep number of transmissions to a minimum.
3. Write message before transmission, if possible.
4. Keep transmission concise and clear.
5. Transmit no classified information in plain language.
6. Avoid linkage between radiotelephone call signs and other types of call signs.

CHAPTER 16

CONVOY OPERATIONS

In chapter 4 we discussed the actions merchant ships should take when at sea at the commencement of a state of war or national emergency to ensure reaching a safe port. During a time of international tension or war, however, even ships in port may be subject to clandestine attack by underwater swimmers or saboteurs.

If there are indications of an attack of this form, ships should come to a state of maximum watertight integrity. Precautions to be taken include the posting of armed sentries, working a bottom line along the length of the ship, rotating the screw and cycling the rudder at irregular intervals as well as dropping small explosives charges, if supplied, over the side on a random basis.

Sabotage is one of the enemy's most deadly weapons that may be used at any time in any port, whether friendly or neutral. Possible methods that may be employed include placing a bomb or incendiary device in the ship or its cargo, putting sand or other abrasives into a lubricating system, concealing tools or other metal pieces in the working part of machinery, and tampering with electrical systems to cause steering gear or refrigeration plant failures.

The best precaution against sabotage is for the entire crew to be constantly on the alert. If no hostile person is able to gain access to the ship, no sabotage can be carried out. Sentries should be posted, all packages and cargo brought aboard should be searched, workmen should only be allowed in those parts of the ship where they are needed, and frequent examinations of all spaces should be made.

INSTITUTING A CONVOY

The basic decision to institute convoying, and the corollary decisions as to types and numbers of ships, can be made only after careful consideration of many factors.

In general terms, the major advantages of a convoy are as follows:

1. The most economical use can be made of the forces available for the protection of shipping.
2. The number of separate targets exposed or available to the enemy is reduced.
3. Concentration of defensive forces yields a greater probability of severely damaging the enemy should he attack.
4. Greater amount of communications equipment within the convoy ensures reliability of ship and shore command and control.
5. The presence of the escort enhances the morale of the crews of the merchant ships.

The use of convoys also has some inherent disadvantages. Tactically, the principal drawback is the fact that the speed of a convoy is limited to the maximum sustained speed of the slowest ship. In addition, the grouping of a large number of ships may prove to be a more attractive target, which can be detected at longer ranges by the enemy than a single ship. Certain inefficiencies in husbanding are also introduced with a convoy system. For example, a number of ships will have to wait after completion of loading until all ships have been loaded and assembled. Port congestion, caused by the large number of ships arriving or sailing on the same day, will lower loading and discharge rates and increase turnaround time.

These advantages and disadvantages must be weighed in any decision to sail a convoy. Detailed consideration must be given to the probable direction and severity of expected attacks and the amount of delay and dislocation to shipping that can be accepted.

DEGREES OF CONTROL

As a general guide to the amount of control that will be prescribed on the sailing and routing of merchant shipping, three basic degrees of control are provided. Determination of the degree

of control to be imposed will be made from a consideration of available intelligence on the form and severity of attacks that can reasonably be expected. The three degrees of control that have been established will be issued by the high command, and authority will be given to subordinate commanders to substitute them at their discretion.

Control ALFA will be enforced in dangerous waters where considerable weight of enemy attack is expected from several sources, including aircraft, submarines, guided missiles, surface craft, mines, or a combination of any of these. This degree of control will require maximum protection by escort forces. Allied shipping, with few exceptions, will be required to sail in convoy and adhere to definite sailing and routing instructions.

Control BRAVO will be enforced in dangerous waters where only sporadic attack is expected. Particularly valuable ships must be escorted. The majority of shipping can proceed unescorted, although all shipping must follow definite sailing and routing instructions.

Control CHARLIE will be enforced where a minimum threat of enemy attack exists and where little protection can be given to shipping. Ships sailing within control CHARLIE areas may be required to observe certain routing instructions, which will be kept to the minimum necessary for providing additional protection in the event of sudden attack. Ships must receive permission to sail.

PREPARATION

After the decision is made to convoy, certain preparations must be made at the level of the high command. Specific requirements that must be verified are as follows:

1. Air and/or surface escorts must be available as dictated by the threat.
2. Naval control shipping officers and staffs must be assigned at all major ports.
3. Convoy commodores and staffs must be available.
4. Necessary communication equipment and other special convoy equipment must be distributed for installation.
5. Necessary stocks of communication publications and other classified publications must be distributed.

Some of the foregoing requirements will be met before the decision to organize a particular convoy. Some of these requirements may not be met; for example, the installation of radio equipment for Navy frequencies on certain merchant ships. Eventually, it will be the concern of the NCSO to ensure that all necessities are provided for ships in convoys that he organizes.

FORMING THE CONVOY

After the national or allied high command issues instructions for instituting convoying and outlines limitations of size and speed, responsibility for operating the convoy system then rests with the operational control authority (OCA). The OCA is charged with communicating details and special instructions to subordinates within the area. In this section, procedures for convoy formation at the lower levels are discussed.

CONVOY COMMAND AND RESPONSIBILITIES

The officers in charge of the convoy and their responsibilities are discussed in the following paragraphs.

Officer in Tactical Command

The officer in tactical command (OTC) is the senior naval officer present or the officer to whom he has delegated command. The OTC is responsible for the defense of the convoy and enforcement of such instructions and orders as are related to the defense of the convoy. When the situation requires, emergency turns and evasive alterations of course by the convoy are ordered by the OTC after consultation with the convoy commodore, if practicable, and are executed upon signal from the convoy commodore's flagship.

Convoy Commodore

The convoy commodore is the officer, naval or merchant, designated by naval authority to command the convoy, subject to orders of the OTC. In the absence of an escort, he takes entire command.

The convoy commodore is responsible for the internal operations of the convoy, including assignment of stations to ships in the convoy after leaving harbor, the issuance of instructions and regulations for the convoy, the safe navigation of the convoy as a whole, and for the communication organization of the convoy within the policy

of the OTC. He should consult with the OTC, whose navigational facilities are normally superior to his, regarding safe navigation, particularly in channels and mineable waters. Under normal conditions, the convoy commodore will control the convoy tactically in accordance with standard instructions for convoys and such additional instructions as he may receive from competent authority. He is also responsible for the readiness for action and conduct in action of the merchant ships under his command. If the commodore of the convoy is incapacitated or forced to relinquish command of the convoy, his duties are assumed by the vice or, failing him, the rear commodore.

A large flag XRAY is to be flown by the commodore's ship while the convoy is forming up or reforming or whenever the commodore wishes to make his ship readily identifiable.

Although the commodore is responsible for the safe conduct and formation of the convoy, masters, individually, are at all times responsible for the safe navigation and handling of their ships.

Vice Commodores and Rear Commodores

In large convoys, a vice commodore usually is assigned and sails in a ship other than the commodore's ship. The vice commodore is responsible for assisting the commodore and replacing the commodore in the event of his removal from the scene. If the convoy splits, the vice commodore takes charge of his portion of the convoy. The vice commodore may be a naval officer especially assigned, or he may be the master or commanding officer of one of the ships in the convoy.

In very large convoys, one or more rear commodores may be assigned. They assist the commodore and vice commodore and act for them in their absence. They may also be assigned to take charge of a section if the convoy splits prior to destination.

Special Commodore

Special commodores are appointed by the convoy commodore as necessary to head leaver sections of the convoy if vice commodores and rear commodores are not designated by the NCSO. Where possible, masters should be selected on the basis of knowledge of the destination port of their leave section. Their duties commence when their sections break off from the main convoy, and they should be supplied all information necessary concerning the ships in their section.

CONVOY CONFERENCE

At the last practicable moment before the ships sail, the convoy conference is held. The object of the convoy conference is to ensure that all concerned with the sailing, safe conduct, and passage of the convoy are adequately informed and instructed on the operation as a whole. At these convoy conferences, masters and all officers concerned should ask for any information they require. In particular, masters should make themselves familiar with what is expected of them when forming up, and they should be prepared to provide details on characteristics of their ships, including the types and frequencies of all radio and electronic equipment.

The conference should be attended by the commodore, vice commodore, rear commodore, officer in tactical command, commanding officers of escort ships, the naval control of shipping officer, naval communications officer, the master, radio officer, the officer in charge of the armament from all ships in the convoy, and the shore-based air support representative, if possible.

DEPARTING THE PORT

At the conclusion of the convoy conference, all personnel who will sail in the convoy proceed immediately to their ships to make final preparations for getting underway.

The convoy is preceded through the swept channel by naval sea-clearing ships, which ensure that the passage is free of hazards. Then, the convoy screening ships or other assigned naval units get underway and fan out from the end of the swept channel to provide close-in ASW protection to the merchant ships until the convoy is formed.

Normally, the convoy guide is the first ship to leave the harbor. The remaining ships follow in a logical sequence based on their position in the convoy formation.

CONVOY FORMATIONS

Convoy formations, which includes line formation, convoy guides, and circular formations, are discussed in the following paragraphs.

LINE FORMATIONS

The arrangement of ships in a convoy is termed *convoy formation*. The usual convoy formation consists of several columns of ships with the leading ship of each column abreast of one another. In this formation, the ships in column are said to be in "line ahead" (fig. 16-1).

The distance between ships in a column and the interval between columns are at the discretion of the commodore. During World War II, the standard procedure was a 1,000-yard interval between columns and a 600-yard distance between ships. This provided adequate maneuvering room and helped to employ to the maximum extent the limited number of escorts.

In a future conflict, it is possible that nuclear weapons may be employed against convoys; thus, consideration has been given to dispersing the ships of a convoy over a large area to minimize the effectiveness of a nuclear detonation. On the other hand, dispersal makes the job of the antisubmarine escorts more trying because they must patrol a much larger area of the ocean. Likewise, visual communications between ships are rendered difficult because of distance. The final determination of distance and interval must be based on the best estimate of the kind of attack that may be expected. Distance and interval information will be issued by the OCA, and sufficient latitude will be given to the NCSO, the OTC, and the convoy commodore to change the formation if circumstances require.

In addition to economic variables, the number of ships in a convoy is limited by such tactical factors as the following:

1. Requirements of maneuvering and signaling
2. Requirements of good station keeping
3. Amount of sea room available
4. Nature of expected attacks

CONVOY GUIDES

One ship in formation will be designated as the convoy guide. It is the duty of the guide to maintain accurately the course and speed ordered. If ships are in a single column, the leading ship will be the guide. If, for any reason, the leading ship falls out of line, the ship next astern of it becomes the guide of the column.

If there are two or more columns in convoy, one of the column guides must also act as

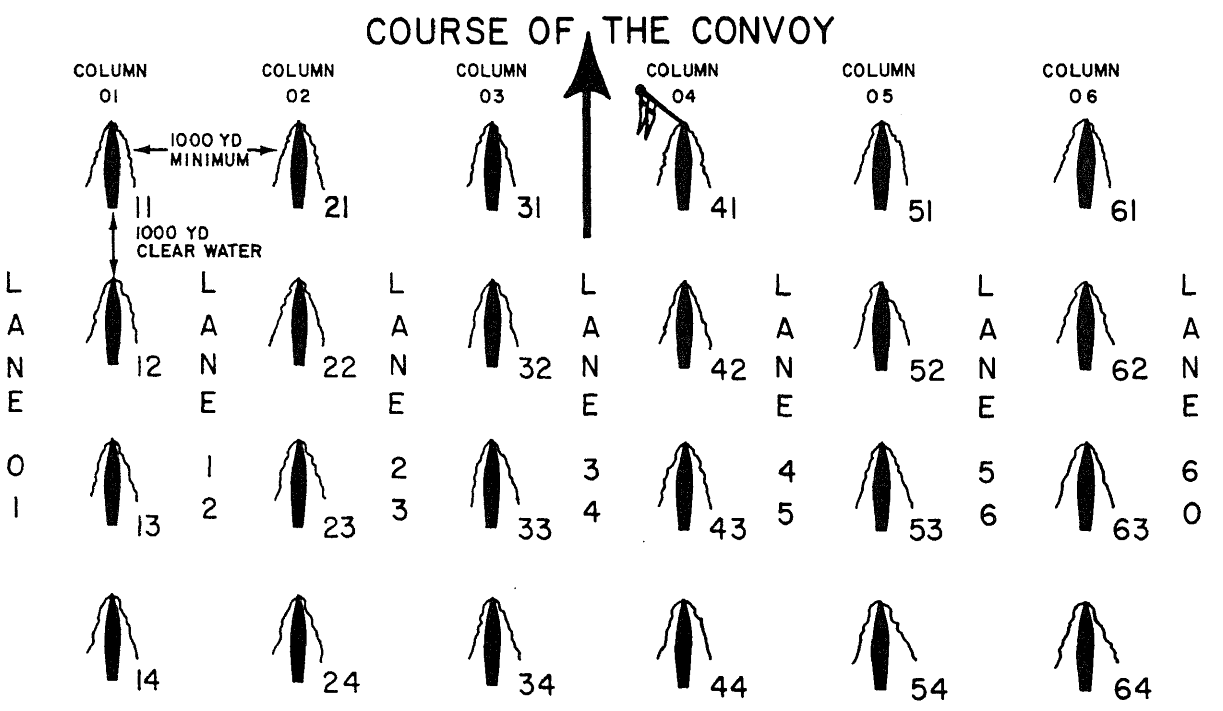


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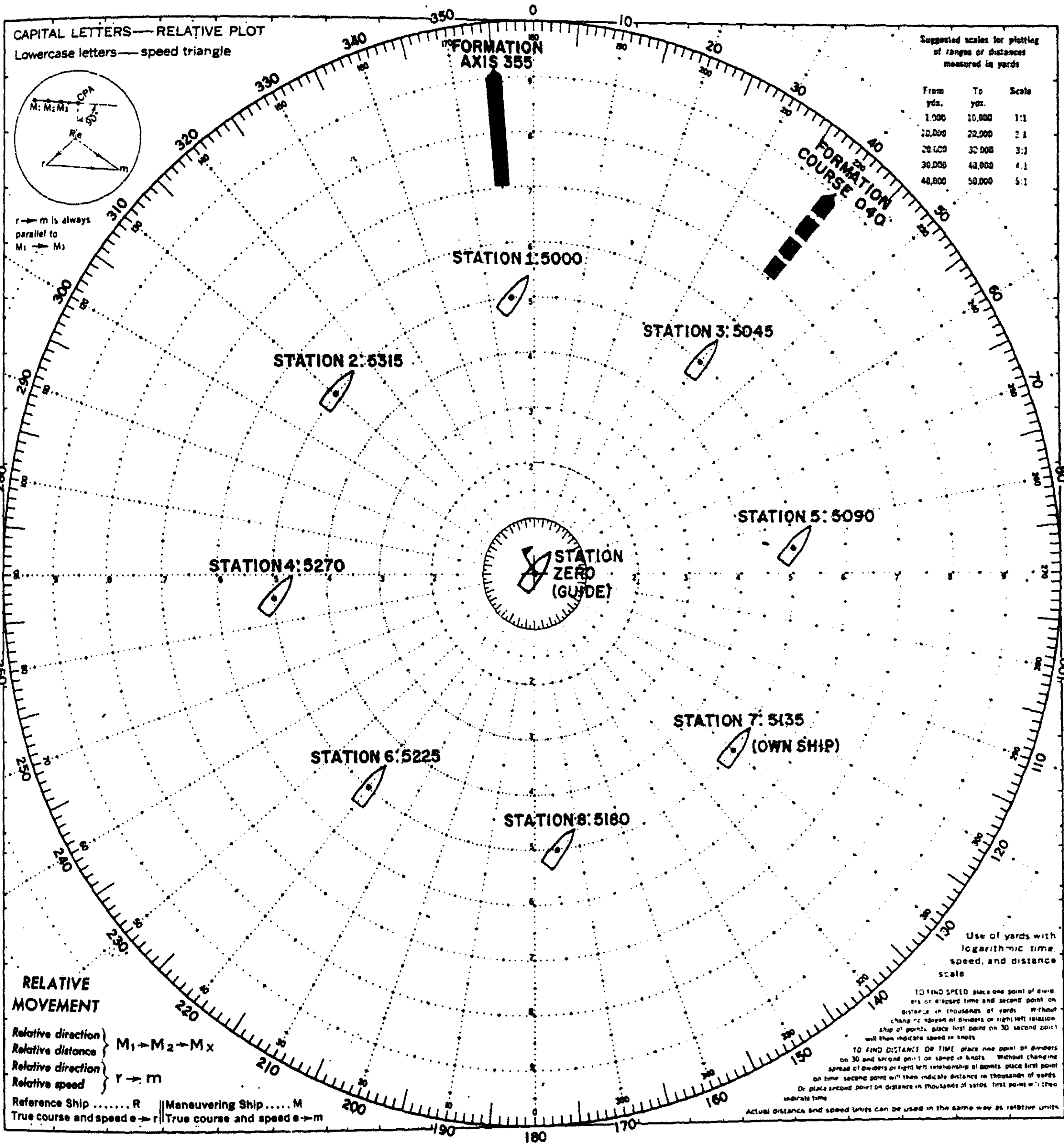
Figure 16-1.—Convoy formation.

convoy guide. The convoy guide must maintain the course and speed ordered, and guides of columns must keep their correct station on it. Ships in each column are to keep station on the guides of their respective columns.

The commodore's ship normally acts as convoy guide, but the commodore may wish some other ship to take over this duty. The ship so ordered is immediately to hoist its largest merchant ensign at the masthead and keep it flying so long as it remains convoy guide.

CIRCULAR FORMATIONS

A circular formation is a tactical arrangement of ships stationed on circles concentric to the formation center and oriented to an axis (fig. 16-2). This configuration provides flexibility in



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that it easily accommodates a transfer from one type, such as cruising, to another type, such as air defense. It also has the advantage of not requiring extensive reorientation for changes in course or formation axis.

Formation center is the origin of the formation axis and is known as station zero. It may or may not be occupied. When station zero is occupied, that ship normally is the formation guide. Formation axis is a true bearing used as a reference line for stationing ships or units.

Circular formations are used primarily by naval warships. They would not normally be ordered for merchant ships.

SCREENS

A screen is an arrangement of ships, submarines, and/or aircraft for the protection of a unit or main body against attack by aircraft, missiles, or submarines. A screen can be designed for a specific purpose or mission, but usually there must be a compromise to provide optimum protection against two or more threats. Since the type of threat can change quickly during an operation, continuous reassessment of the situation is necessary to maintain the efficiency of the screen. There are four basic types of screens: sector, skeleton, helicopter windline, and departure/entry.

STATION KEEPING

One of the main points that should be stressed at the convoy conference is the importance of good station keeping. How this quality bears directly on the safety of the convoy must be impressed on the individual masters. They, in turn, must relay this information to their deck officers, who bear the day-to-day responsibility. It is particularly important that the column guides keep accurate station on the convoy guide.

If a ship does get out of station, drastic alterations to regain position should be avoided. Constantly applied changes of a few degrees or 1 or 2 knots, although requiring longer time to accomplish the desired alteration, will bring the ship back to proper station in sufficient time for all except emergency conditions. In addition, gradual changes are preferable in terms of the adjustment that must be made by ships astern of the faulty station keeper.

Maintaining station at night is especially difficult. Experience in World War II proved that the greatest amount of straggling occurred in hours of darkness, and very often a convoy would be almost completely dispersed by dawn—the favorite time for submarine attack. Escorts that sometimes were insufficient in number, under ideal conditions, were obliged to attempt to bring the convoy back together, while fighting off a submarine or air attack at the same time. For these reasons, losses were particularly heavy during the time immediately preceding and following dawn.

STRAGGLERS

Stragglers present certain unique problems to the NCSO and the OCA. Because they are no longer with the convoy, there are certain things that can no longer be assumed about them concerning their positions, progress, and general state. At the same time, stragglers cannot be required to communicate too frequently with the OCA or NCSO for fear of revealing their position to the enemy.

In the first place, a ship that is forced to straggle from a convoy must make every effort to rejoin by using noon rendezvous positions—although, for obvious reasons, the ship is not supposed to try to rejoin during hours of darkness.

If the ship is unable to rejoin, the master is required to open the straggler's instructions and proceed according to them. The escort force commander or the convoy commodore should report the condition of the straggler and its new ETA if known. In no instance should the master of the straggler attempt to report to the cognizant OCA unless conditions of radio silence permit. The OCA receiving this information is obliged to pass it on to the OCAs of other areas through which the straggler is expected to pass, to the NCSO at the terminal port, and the national naval ministry of the departure port.

SPECIAL MANEUVERING RULES

Although naval vessels are required to observe appropriate rules of the road, there are circumstances wherein special rules override the international rules. (Some of these special rules have been incorporated into the 1972 revision of the *International Rules of the Road*.) The following rules apply to naval vessels whether steaming independently or in formation:

1. Ships engaged in replenishment operations (except VERTREP) have the right of way over ships engaged in flight operations.
2. Ships launching or recovering aircraft have the right of way except over ships engaged in alongside replenishment or in minesweeping operations.

3. Screen ships are to keep clear of ships in the main body. However, a helicopter hovering with its sonar down must not be approached within 500 yards.

FORMATION MANEUVERING

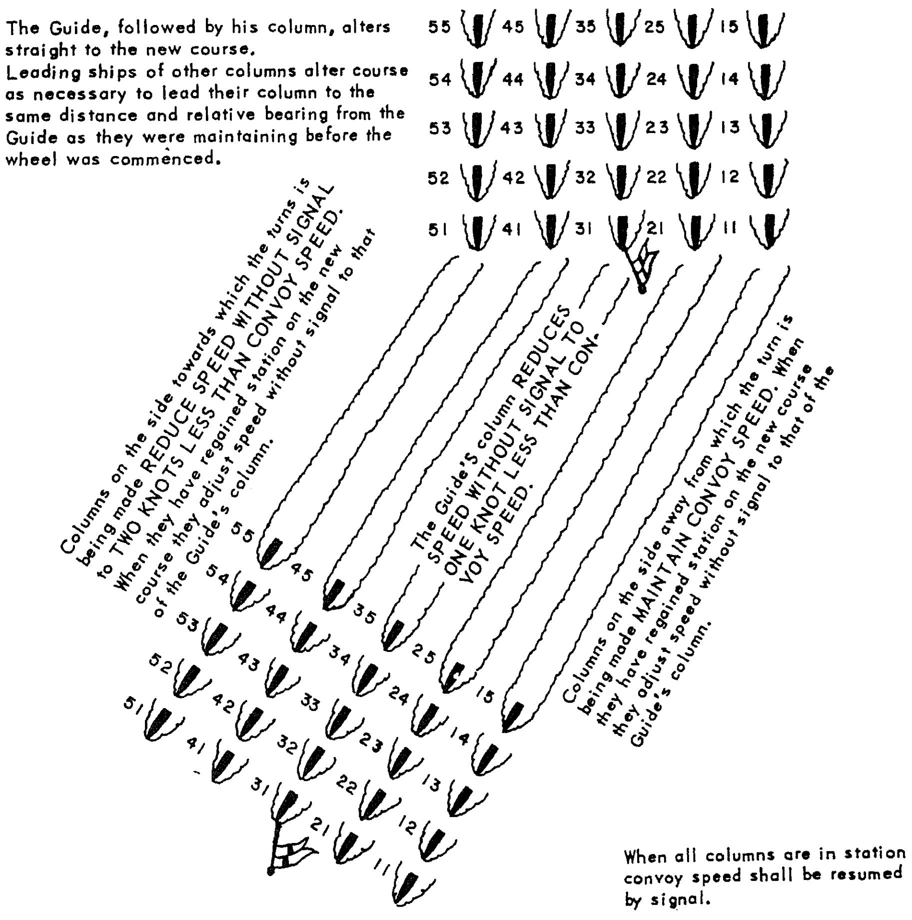
Three methods are available for altering course when a convoy is in the standard line ahead formation shown in figure 16-1. The commodore may order the course altered in succession (a wheel); column leaders only may turn simultaneously with the remaining ships following in their wakes; or all ships may turn simultaneously. Details on all of the maneuvers may be found in ACP 148. A brief description of each is given in the following paragraphs.

Wheeling

Wheeling is the normal method of altering course when a convoy is steaming in two or more columns. In clear weather, the course may be altered in one wheel any amount up to 45°. During reduced visibility, the course should not be changed more than 20° in one wheel.

The signal for this maneuver is WHISKEY preceded or followed by three numerals, which indicate the new course (W225). Maneuvering signals from ACP 148 are contained in appendix A.

When using this method, the guide of the convoy turns to the new course under easy rudder, and leading ships of columns alter course as necessary to regain the same relative station on the guide as they were maintaining before the wheel was commenced. Ships in columns follow the leading ship of their column maintaining correct distance and relative bearing from it. Thus, when the wheel is completed, all ships in the convoy will be in the same relative position as they were in before the wheel commenced, and there is no change of guide (fig. 16-3). Turning



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blasts on the whistle are always made by leading ships as the rudder is put over.

It is obvious that columns must proceed at different speeds to carry out a wheel, or else the columns on the side of the guide toward which the wheel is being made will find themselves ahead of station, while the columns on the side away from which the wheel is being made will find themselves astern of station. Each column is to adjust its speed to that of the guide's column (that is, to 1 knot less than convoy speed) without signal when it is on the new course and has regained its correct station. The commodore will order the resumption of convoy speed when he thinks fit by making the proper signal.

Turning Column Leaders Simultaneously

This method of altering course is suitable when a convoy is in several columns and only a temporary alteration of course is necessary. The appropriate signal, shown in appendix A, is FOXTROT preceded or followed by three numerals indicating the new course (F210).

When using this method, the leading ships of all columns alter their course simultaneously to the new course; the remaining ships follow in the wake of the leading ship of their column (fig. 16-4). No change of course greater than 30° from the course for which the convoy formation is oriented will be effected by use of this method. All ships maintain convoy speed throughout the maneuver. Turning blasts on the whistle are always made by leading ships as the rudder is put over.

All Ships Turn Simultaneously

A simultaneous turn is used to transfer a convoy bodily to port or starboard, normally to avoid danger. The signal TANGO following or followed by three numerals may be used. In an emergency, however, several other signals are available to turn the convoy 45° to port or starboard. See appendix A.

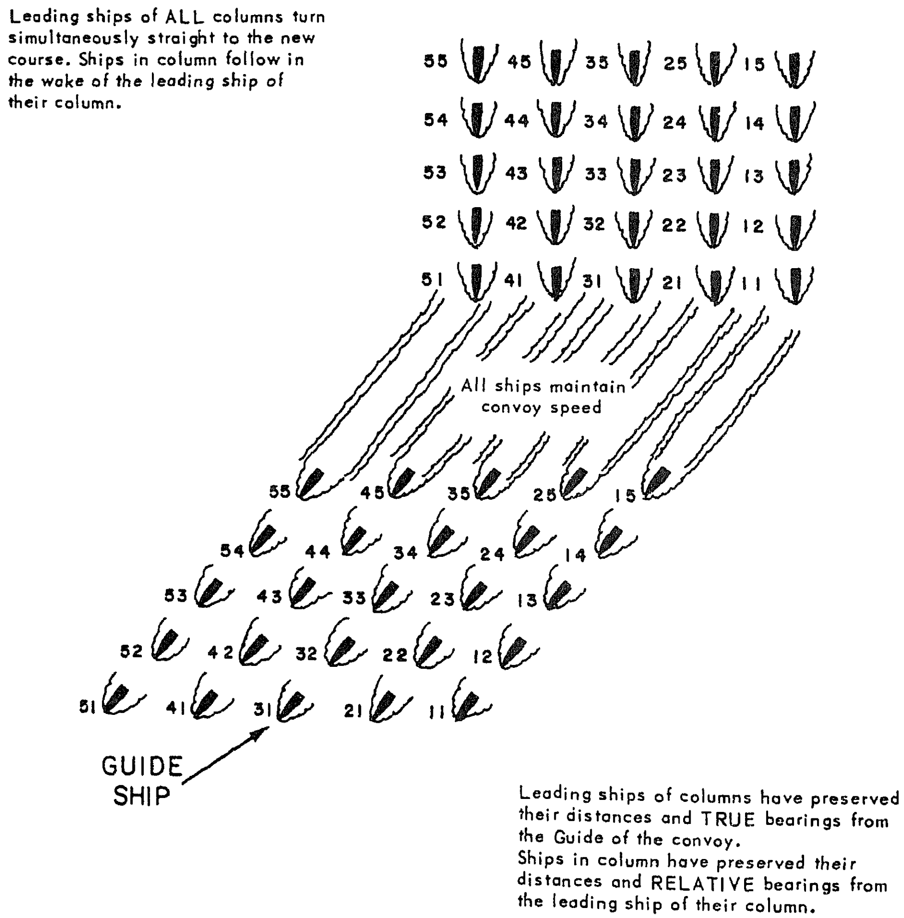

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Figure 16-4.—Turning column leaders simultaneously.

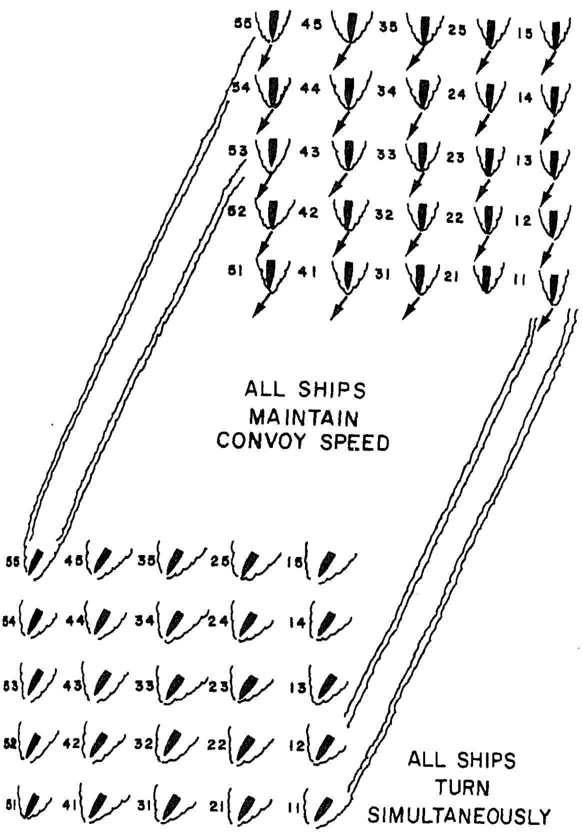

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Figure 16-5.—Simultaneous turn used to transfer a convoy bodily to port or starboard.

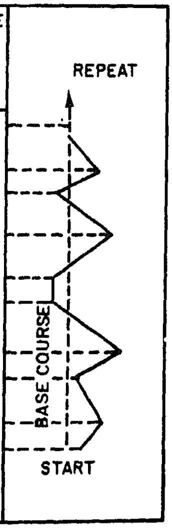
When using this method, all ships alter their course simultaneously to the same course; each maintaining their true bearing and distance, but changing their relative bearings (fig. 16-5). All ships maintain convoy speed through the maneuver. Turning blast(s) on the whistle are always made as rudders are put over. When the ships in the convoy have dissimilar turning characteristics, it is inadvisable to alter course together in excess of 90° in one step.

ZIGZAGGING

The term *zigzagging* is used to describe a series of straight line variations from the base course, which are performed in accordance with a preconceived plan. When carrying out a zigzag, all ships turn simultaneously for each alteration of course and thus maintain the same true bearings from each other throughout the zigzag.

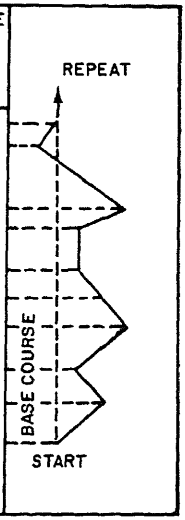
The decision to zigzag and the type of plan chosen are made by the escort force commander after consulting with the commodore. The kinds of zigzag plans and instructions for their use are issued by the OCA or higher naval authority and distributed by the NCSO. General definitions and instructions applying to zigzagging are given in ACP 148. Figure 16-6 is an example of a zigzag plan.

HR	MIN	TURN	ANGLE OFF BASE CO
3	00	61S	40S
2	41	56P	21P
2	26	55S	35S
2	00	40P	20P
1	38	20S	20S
1	23	30S	0
1	01	60P	30P
0	47	50S	30S
0	20	60P	20P
0	00	40S	40S



ZIGZAG NO.1
FOR SPEEDS 7-35 KNOTS.
DISTANCE MADE GOOD--90 PERCENT OF DISTANCE RUN.

HR	MIN	TURN	ANGLE OFF BASE CO
3	00	12S	30S
2	40	58S	18S
2	14	70P	40P
1	58	30S	30S
1	30	45S	0
1	19	20P	45P
1	06	45P	25P
0	44	35S	20S
0	26	45P	15P
0	00	30S	30S



ZIGZAG NO.2
FOR SPEEDS 9-35 KNOTS.
DISTANCE MADE GOOD--90 PERCENT OF DISTANCE RUN.

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Figure 16-6.—Zigzag plans.

EMERGENCY MANEUVERS

There are several emergency maneuvers in ACP 148 that allow the OTC and commodore to radically alter the convoy formation when under attack. The type of maneuver used is dependent on the nature of the threat.

Emergency Convoy Formation

In the event of an attack by nuclear weapons, it may be necessary to increase the distance between columns and ships considerably beyond that of the normal formation. In this instance, the commodore will signal FORM EMERGENCY FORMATION (XDB) and indicate the interval desired between columns and between ships.

Scattering Fanwise

If, upon encountering superior enemy forces, it is considered advisable to disperse the convoy, SCATTER FANWISE AND PROCEED AT YOUR UTMOST SPEED (pennant 6) will be ordered. All ships will increase to full speed immediately and steer slightly divergent courses from each other when there is adequate sea room (fig. 16-7).

Should the attacking forces be concentrated ahead of the convoy, the commodore will first turn the formation 90° off the base course before ordering the ships to scatter (fig. 16-8).

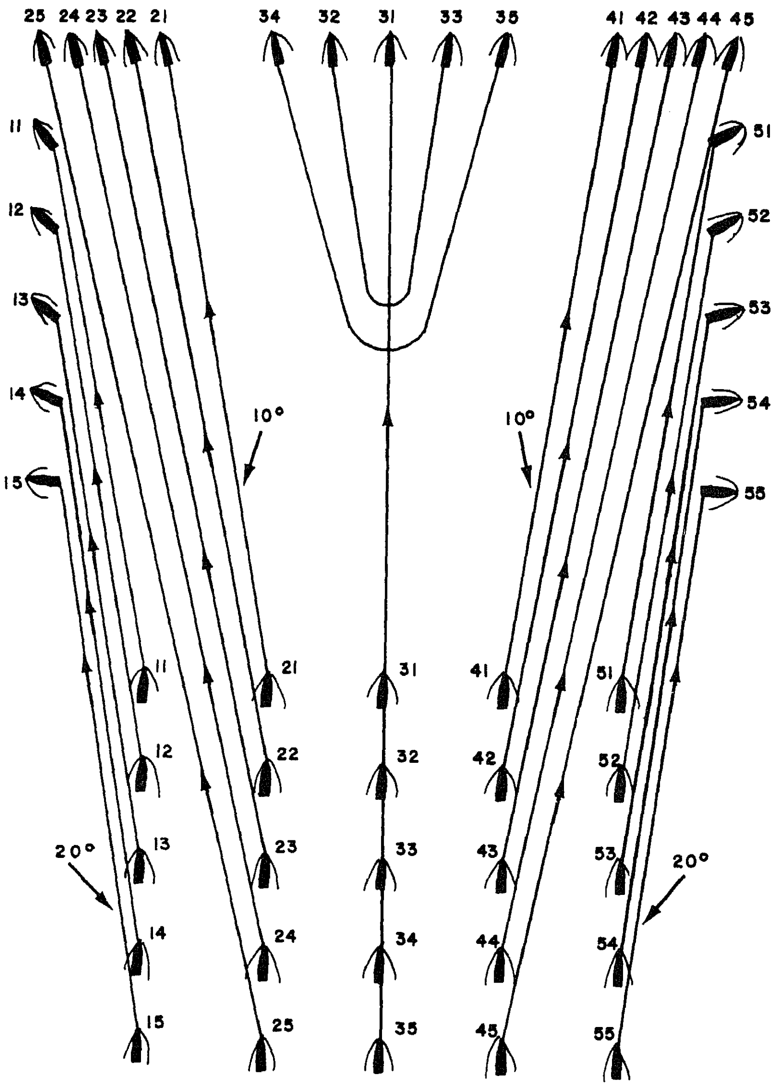

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Figure 16-7.—Scattering fanwise.

Starring

If the convoy is attacked by enemy aircraft or missiles, the signal to STAR (pennant 9) may be made. This signal is to be obeyed as soon as it is understood, and all ships are to proceed as shown in figure 16-9 at top speed.

When the attack is over, ships will reform on the convoy guide at the noon rendezvous position or other such position as may be designated.

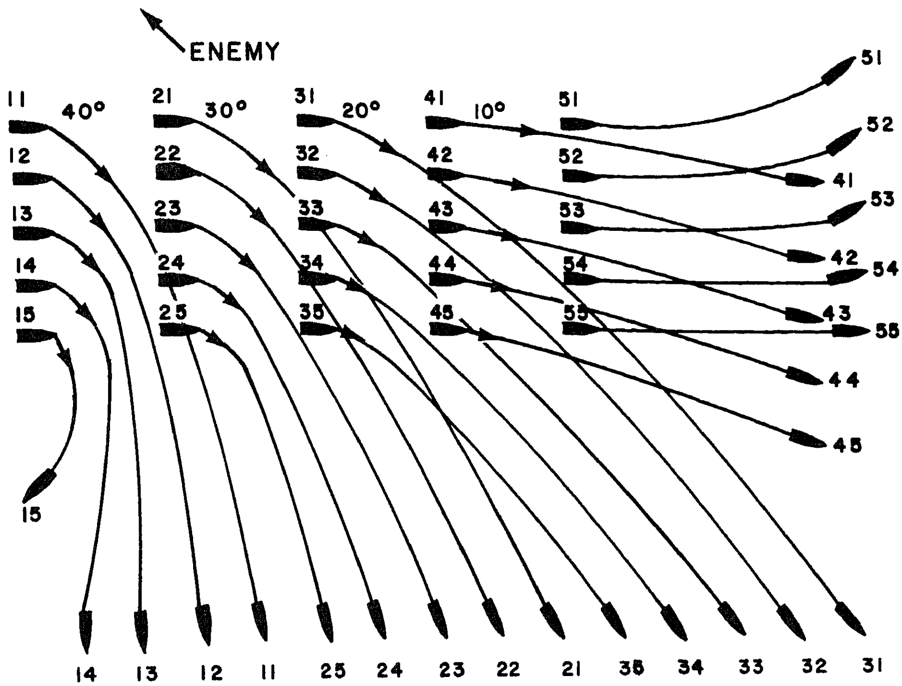

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Figure 16-8.—Scattering when 90° off the mean course.

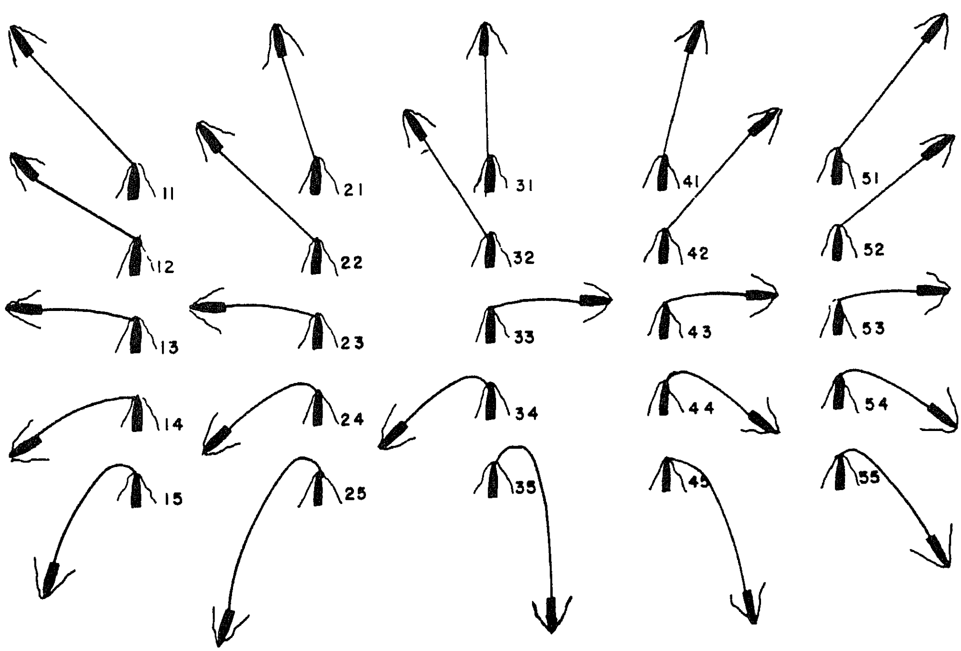

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Figure 16-9.—Starring.

SPECIAL CONVOY PROCEDURES

Special convoy procedures are discussed in the following paragraphs.

Columns Astern

This maneuver is used to reduce the front of the convoy by placing the outboard columns astern of the next inboard column. Upon execution of the signal (XDE), the ships in the wing columns reduce speed and the leading ships maneuver as necessary to form astern. The remaining ships follow in the wake of their column guide, maintaining relative bearings and distance.

Single Line Ahead

When a two-column convoy is to be formed into a single line, XDD is ordered by the commodore. The convoy guide's column maintains their course and speed. The ships of the other column reduce speed and follow in the wake of the lead ship as it maneuvers to form astern.

Exchanging Stations

If two ships are ordered to exchange stations (XDH), they maneuver as follows:

1. If in the same column, the ship farthest ahead is to haul out of the line to port, and the ship in the rear is to haul out of the line to starboard.
2. If in different columns, the ship leaving the port column is always to pass astern of the ship leaving the starboard columns.

Ships exchanging stations must keep out of the way of other ships in the convoy, and they are also to assume the convoy internal call sign of the station.

Low Visibility Station Keeping

When visibility is less than 1 mile and the tactical situation precludes using radar, the convoy commodore may order the use of fog buoys (fig. 16-10).

Fog buoys are to be streamed upon receipt of orders at the end of 300 fathoms of 2-inch rope. Ships are to close to keep the fog buoy of the ship ahead in sight. A good lookout must be maintained in the bow so as to keep the bridge informed of the position of the next ahead's fog buoy if it cannot be seen from the bridge. The best position in which to keep the ship ahead's fog buoy is between the bridge and the stem, about 20 yards away from the ship, where it should be clearly visible from the bridge. It may not be practicable for large vessels to do this because bridge-to-stem distances are too great, and these ships are not sufficiently maneuverable. Odd numbered ships are to keep the fog buoy on the starboard bow, and even numbered ships are to keep it on the port bow. If the fog buoy is lost from sight, large alterations of course or speed must be avoided when attempting to find it again. When keeping station in fog, speed should never be varied more than half a knot from the speed ordered for the convoy, nor course altered more than 2° from the course ordered.

Man Overboard

A ship in convoy that loses a man overboard is to immediately advise the convoy on voice radio, to hoist flag "O" by day, and to flash "O" to ships astern both day and night. The ship with a man overboard is normally to take no recovery action, except maneuvering to avoid striking the person with the propeller. Recovery action will be taken by an escort or rescue ship or by the last ship in the column if no escort or rescue ship is available. On receipt of the message, the nearest escort or rescue ship will proceed immediately to render assistance.

RELATIONSHIP BETWEEN NAVAL ESCORT AND MERCHANT SHIPS

Because the escort force commander is designated the officer in tactical command of a convoy, masters are obligated to obey the commands of the escort force commander and the convoy commodore. The master,

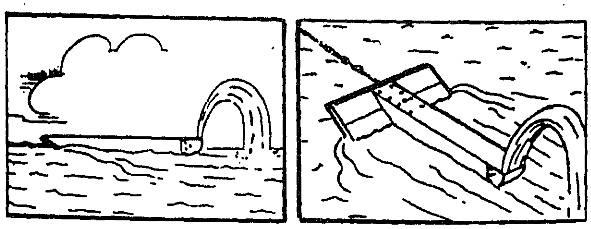

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Figure 16-10.—Convoy fog buoy.

notwithstanding, always retains primary responsibility for the safe navigation of his ship.

Commodores and escort force commanders, generally, are not answerable for the action or inaction of individual ships, even though they may be responding to a signal ordered by either the commodore or the escort force commander. Escorting vessels and convoy formations are designated to provide military security and defense against enemy attack; but, as pointed out, none of these measures relieves the master from responsibility for his ship.

GENERAL RESPONSIBILITIES

The responsibilities of a master for his ship do not break down easily into peacetime and wartime categories. Such distinction that can be made centers around wartime obligations, an extension of these responsibilities that are a shipmaster's by law, regulation, and tradition during peaceful times. Basic responsibility for the safety of a ship was elaborated on previously. In this present context, it is best considered as the basis from which come the many additional wartime precautions that a master must take. Specific responsibilities, to be examined now, apply chiefly to the master of a ship sailing in convoy.

Navigation

The convoy instructions contain detailed information concerning the showing of navigational lights by ships in the convoy. Generally speaking, all ships must operate in a DARKENED SHIP condition and must show navigational lights only to avoid collision or when an unusual condition makes their use absolutely necessary. If navigational lights are displayed, they must be able to be turned on and off immediately; and, if they are used, all lights required by a particular situation must be shown. Lights should be fitted with dimming devices.

Electronic, navigational aid equipment that transmits a signal must be sharply limited. Developments in electronic countermeasures (ECM) equipment have brought about a situation whereby accurate fixes can be taken in a few seconds on emitting electronic equipment. In most instances, radio and radar guardships must be designated before sailing time, and they must perform all transmitting tasks for the convoy. Usually, these ships are selected from the naval escorts because of their better equipment and more highly trained personnel. If a merchant ship is designated for radio or radar guardship, its duties are outlined in a supplement to the convoy communication plan. Each master is required to keep his own reckoning and to signal his noon position to the commodore within an hour after noon sights are taken. The commodore transmits his position to the rest of the convoy from time to time for use as a reference position.

Damage Control

Implementation of good damage control practices is a vital need. All ships have procedures for localizing and controlling damage and fighting fires. But a need exists to expand and standardize damage control practices and to train all crew members in damage control and firefighting drills.

WATERTIGHT INTEGRITY.—To reduce the amount of water entry in the event of damage to the ship, take the following precautions:

1. Ensure that all main transverse bulkheads are watertight.
2. All interior openings, other than accommodation doors, must be kept closed and dogged down except when in immediate use.
3. Masters should maintain a closure log, and make entries in it each time a watertight fitting is opened and closed at sea.
4. Side scuttles and other openings in the ship's side below the uppermost continuous deck normally should be kept closed at sea.
5. Collision mats and similar emergency repair material should be rigged and available for immediate use.

OTHER PRECAUTIONS.—Many other measures must be taken by the ship's master to ensure that his crew and his ship are ready in all respects to combat the effects of enemy action at sea. Realistic planning and constant drills make for success in damage control. Elements of particular importance are as follows:

1. A system of reporting damage to the master, the chief engineer, and the cargo officer
2. A system to designate positions of bulkheads and watertight compartments and the nature and distribution of the cargo
3. Conditions under which ship's main propulsion and auxiliary equipment will be secured to prevent the spread of damage
4. Scuttling arrangements

5. Locations and capacities of all fire-fighting ıuipment and other emergency equipment

bandoning Ship

Certain precautions can be taken by a master efore sailing to increase significantly the survival ' his crew if the ship should be damaged so verely that the only possible course is to andon ship.

Life jackets must be issued to all crew embers with instructions that they are to be orn or carried at all times while awake and kept arby while asleep. Extra life jackets should be ailable at abandon ship stations. While the conoy is passing through a danger zone, lifeboats davits should be swung out ready for instant wering, unless the master deems it inadvisable cause of possible weather damage to the boats. fe rafts should be rigged for quick release so ey will float free if the ship sinks.

The decision to abandon ship is the province ' the master. It is a consideration that he must ke very seriously. Initial damage often seems orse than it really is, and if initial flooding can checked, a ship that is apparently heavily ımaged can be saved. The master's underandable concern for the safety of his crew must weighed against the ability of the ship to stay loat and the effect of the loss of the cargo that e ship is carrying. It can never be an easy cision.

If the determination is reached to abandon ip, way must be immediately checked, main opulsion machinery shut down, and the fuel oil stem secured.

If circumstances permit, a skeleton force from e merchant crew should stay aboard to man ımps and perform other damage control actions keep the ship afloat as long as possible and rhaps to save it. Additional detailed instructions ı emergency procedures to be followed by dividual survivors and personnel in lifeboats are ntained in ACP 148.

uttling

If it appears imminent that a ship will fall to enemy hands and no assistance is possible, en the ship should be scuttled. The best method scuttling a ship is the decision of the master d the chief engineer, hence no scuttling produre will be outlined in this text. Each ship der the control of the NCSORG should make ovisions for such an eventuality, and reliable crew members should be detailed to form the scuttling party. If any of these emergency measures are to be taken, it is highly important that the master inform the commodore by the most rapid means.

Rescue and Distress

Naval warships and aircraft will respond to a distress message from a sinking ship as quickly as circumstances permit. However, there can be no precise estimate of when, or in what numbers, assisting units will converge. Masters should be advised of these facts, and they should also be advised that if a distress message is acknowledged, help will come.

If special rescue ships or tugs travel with a convoy, they will respond immediately to any emergency not arising from enemy action, such as collision or man overboard. If the distressed ship has been hit, rescue operations cannot be undertaken until the threat of attack no longer exists. Several ships milling around the scene of a sinking would provide an irresistible target for a submarine. If special rescue ships are not assigned, the rear ships of columns normally are designated to perform rescue duties.

ENEMY ACTION

Major aspects of the air, surface, and subsurface threat to merchant ships, as well as U.S. Navy AAW and ASW capabilities, were discussed previously. Some general comments in relation to enemy action against a convoy are presented here.

AIR DEFENSE

Air defense of a convoy at sea includes both strategic and tactical defense. Strategic defense simply means (1) removal of the potential target (the convoy) from the areas in which enemy aircraft can operate effectively, or (2) reduction of effective enemy air operations in the area in which the convoy has to pass.

Tactical defense will come from three sources: interceptor aircraft accompanying the convoy on carriers or operating from land bases or naval task forces; antiair warfare armament within the convoy, including missiles and conventional armament; or passive defense measures taken by the convoy, such as evasive steering or smoke screening.

Early warning of impending air attack is probably the most important facet of the air defense problem. Because of the great speed and other high-performance qualities of present day aircraft, early warning must be accomplished at a sufficient distance to allow the assembling of defensive weapons and, if necessary, the dispersal of the convoy. One or more of the escorting ships normally will be assigned as radar guardship to detect incoming raids and report their composition, speed, and other characteristics to the OTC.

Defense of the convoy will be coordinated from the ship detailed as antiair warfare defense ship. This usually will be the ship of the escort force commander as OTC. If the presence of unidentified aircraft is known, a prearranged signal will be hoisted at the dip, accompanied by a prolonged whistle blast, to call attention to it. In the event that the unidentified aircraft are classified as friendly, the signal will be hauled down. If they are enemy, the signal will be closed up and another prolonged whistle blast will be sounded and repeated. At night, this visual signal will be in light and will also be accompanied by the whistle blast. In a widely dispersed convoy, light and sound-repeating ships will relay these signals to other ships.

SUBMARINE ACTION

Potential enemies have large and effective submarine forces. The variety of weapons that a modern submarine can deliver, combined with its capability for high-speed underwater operations of long duration, make it a dangerous adversary.

In a future conflict, it is unlikely that merchant ships will be able to provide much of their own active defense against submarines through the use of deck armament. All modern submarines lack deck guns because of their greatly increased effectiveness in undersea attack. Therefore, the likelihood of surface attack from submarines is slight.

The three most important facts that must be impressed on masters in advance of sailing are as follows:

1. An accurate interpretation of the capabilities and limitations of the enemy's submarines and an estimate of the extent of the submarine threat over the route of the impending convoy.
2. A presentation and explanation of emergency maneuvering procedures to avoid direct torpedo or mine attack.
3. An explanation of the emergency convoy formations illustrated in ACP 148.

A realistic understanding of the threat and an immediate and disciplined response to the orders of the OTC or convoy commodore are the most significant contributions that a merchant master can make toward the success of the antisubmarine defense efforts of the entire convoy.

APPENDIX A

ACP-148B MANEUVERING SIGNALS

ANNEX B TO ACP-148B—MANEUVERING SIGNALS
ANNEX C TO ACP-148B—SUPPLEMENTARY SIGNALS
ANNEX D TO ACP-148B—COLORED LIGHT SIGNALS
ANNEX E TO ACP-148B—PYROTECHNIC SIGNALS

ANNEX B

MANEUVERING SIGNALS

MANEUVERING SIGNALS

1. Alteration of course in succession by wheeling. This is the normal way of altering course when a convoy is steaming in two or more columns. For details as to how to execute the maneuver see ACP 148, paragraph 617.

SIGNAL	HOW MADE	MEANING	EXECUTION	REMARKS
WHISKEY followed by three numerals	VOICE	Wheel to Starboard to course indicated.	On receipt of STANDBY—EXECUTE. Commodore and leading ships make one short blast on the whistle.	
Three numerals followed by WHISKEY	VOICE	Wheel to Port to course indicated	On receipt of STANDBY—EXECUTE. Commodore and leading ships make two short blasts on the whistle.	
WHISKEY—Superior to three numeral pennants	FLAGS	Wheel to Starboard to course indicated.	When flags are hauled down. Commodore and leading ships make one short blast on the whistle.	Commodore will give the signal "STOP ZIGZAGGING AND STEER COURSE ___ prior to this maneuver.
WHISKEY—INFERIOR to three numeral pennants	FLAGS	Wheel to Port to course indicated.	When flags are hauled down. Commodore and leading ships give two short blasts on the whistle.	
GN RD GN	COLORED LIGHTS	FIXED—Wheel 20 degrees to starboard. FLASHING—Wheel 5 degrees to Starboard.	When lights are extinguished. Commodore and leading ships make one short blast on the whistle.	ZIG ZAG will be stopped by signal and base course resumed.
RD GN RD	COLORED LIGHTS	FIXED—Wheel 20 degrees to port. FLASHING—Wheel 5 degrees to Port.	When lights are extinguished. Commodore and leading ships make two short blasts on the whistle.	
GN GN GN	COLORED LIGHTS	FIXED—Resume zig zag. FLASHING—Stop zig zag, resume base course.	When lights are extinguished. Commodore and lead ships make appropriate whistle signal in accordance with International Rules.	

2. Alteration of Course, Column leaders turning simultaneously and the remainder following in succession. This method of altering course is suitable when a convoy is in several columns, and is used instead of a turn when the required alteration of course can be foreseen. For details as to how to execute the maneuver see ACP 148, paragraph 618.

SIGNAL	HOW MADE	MEANING	EXECUTION	REMARKS
FOXTROT followed by three numerals	VOICE	Leading ships turn simultaneously to Starboard to course indicated, remainder following in the wake of their leading ship.	On receipt of STANDBY—EXECUTE. Commodore and leading ships make one short blast on the whistle.	

SIGNAL	HOW MADE	MEANING	EXECUTION	REMARKS
Three numerals followed by FOXTROT	VOICE	Leading ships turn simultaneously to Port to course indicated, remainder following in the wake of their leading ship.	On receipt of STANDBY—EXECUTE. Commodore and leading ships make two blasts on the whistle.	
FOXTROT—Superior to three numeral pennants	FLAGS	Leading ships turn simultaneously to Starboard to course indicated, remainder following in the wake of their leading ship.	When flags are hauled down. Commodore and leading ships make one short blast on the whistle.	NOTE: ZIG ZAG in progress is cancelled automatically.
FOXTROT—Inferior to three numeral pennants	FLAGS	Leading ships turn simultaneously to Port to course indicated, remainder following in the wake of their leading ship.	When the flags are hauled down. Commodore and leading ships make two short blasts on the whistle.	

3. Alteration of Course, All Ships Turning Simultaneously. This method of altering course is used for transferring a Convoy bodily to starboard or port in order to avoid a danger. For details as to how to execute the maneuver see ACP 148, paragraphs 619 and 620.

a. Emergency Turn

SIGNAL	HOW MADE	MEANING	EXECUTION	REMARKS
Emergency turn to Starboard	VOICE	Turn simultaneously 45 degrees to Starboard.	On receipt of STANDBY—EXECUTE. All ships make one short blast on the whistle.	
Emergency turn to Port	VOICE	Turn simultaneously 45 degrees to Port.	On receipt of STANDBY—EXECUTE. All ships make two short blasts on the whistle.	This alteration is reckoned from the course of the convoy at the moment of execution. ZIGZAG in progress is cancelled automatically.
Flag "E" and 15 second blast on the whistle repeated by leading ships	FLAGS	Turn simultaneously 45 degrees to Starboard.	When the flag is hauled down and one short blast on the whistle repeated by all ships.	
Flag "I" and 15 second blast on the whistle repeated by leading ships	FLAGS	Turn simultaneously 45 degrees to Port.	When the flag is hauled down and two short blasts on the whistle repeated by all ships.	

3. (Continued)

SIGNAL	HOW MADE	MEANING	EXECUTION	REMARKS
15 second blast on the whistle repeated by leading ships	SOUND	Turn simultaneously 45 degrees (To the side indicated by the following turning blast).	One short blast on the whistle; turn to starboard. Two short blasts on the whistle; turn to port. (Turning blast to be repeated by all ships.)	This alteration is reckoned from the course of the convoy at the moment of execution. ZIGZAG in progress is cancelled automatically.
GN GN RD	COLORED LIGHTS	Turn simultaneously 45 degrees to Starboard.	When lights are extinguished and firing of one green Very light. All ships sound one short blast on the whistle.	
RD RD GN	COLORED LIGHTS	Turn simultaneously 45 degrees to Port.	When lights are extinguished and firing of two red Very lights. All ships sound two short blasts on the whistle.	

b. Turn. All ships turning simultaneously.

SIGNAL	HOW MADE	MEANING	EXECUTION	REMARKS
TANGO followed by three numerals	VOICE	Turn simultaneously to Starboard to course indicated.	On receipt of STANDBY— EXECUTE. All ships sound one short blast on the whistle.	NOTE: Zigzag in progress is cancelled automatically.
Three numerals followed by TANGO	VOICE	Turn simultaneously to Port to course indicated.	On receipt of STANDBY— EXECUTE. All ships make two short blasts on the whistle.	
TANGO Superior to three numeral pennants	FLAGS	Turn simultaneously to Starboard to course indicated.	When flags are hauled down. All ships make one short blast on the whistle.	
TANGO inferior to three numeral pennants	FLAGS	Turn simultaneously to Port to course indicated.	When flags are hauled down. All ships make two short blasts on the whistle.	

ANNEX C

SUPPLEMENTARY SIGNALS

SUPPLEMENTARY SIGNALS

1. Single Letter Signals

CODE	MEANING		
E	Emergency turn 45 degrees to starboard from present course, or if in a turn from the course to which turning. (Stop Zigzagging. Maintain speed) (See paragraph 203a).		
F (Preceding or following 3 numerals)	Follow leading ships. Leading ships turn simultaneously to course indicated and the remainder follow in succession (Stop Zigzagging. Maintain speed. See paragraph 202).		
H	Operating helicopters. AT DIP: Am preparing to receive helicopter. CLOSE UP: Am on steady course and speed; ready to receive or be closed by helicopter. HAULED DOWN: Helicopter operations completed.		
I	Emergency turn 45 degrees to port from present course, or if a turn from the course to which turning. (Stop Zigzagging. Maintain speed. See paragraph 203a).		
T (preceding or following 3 numerals)	All ships turn to course indicated. (Stop zigzagging. Maintain speed. See paragraph 203b).		
W (Preceding or following 3 numerals)	Alter course by wheeling as indicated. (Adjust speed as necessary. See paragraph 201).		
X (Flag)	This ship is the Convoy Commodore.		
Y	Heaving line transfer. Flown at yardarm on side where ships will close each other. Meaning: I have mail or other light material for transfer.		
	AT DIP	CLOSE UP	HAULING DOWN
By closing ship	Am preparing to make approach	Commencing approach	Line passed
By ship being closed	Am preparing to receive you	Am ready to receive your heaving line. Am on steady course and speed.	Line received.
4th Substitute	Used by a warship to indicate that signal(s) flying are taken from this publication.		

2. Single Pennant Signals

PENNANT	MEANING
Ø	Open fire
1	Cease fire
2	Nuclear warning. Switch off ventilation system. Do not man guns.
3	Sighted mine.
4	Attack warning. Man guns.
5	Sighted submarine, snorkel or periscope.
6	Scatter fanwise and proceed at utmost speed. See Table 501 and ACP 148 paragraph 629 for maneuvering instructions.
7	Sighted torpedo or torpedo track.
8	All clear. (Aircraft in vicinity are friendly).
9	"Star" and proceed at utmost speed. See Table 501 and ACP 148 paragraph 630 for maneuvering instructions.

NOTE: Pennants 3, 5, and 7. Bearings may be added to these signals.

3. Three Letter Signals

COMMUNICATIONS

CODE	MEANING
XAA	Operate under radio readiness condition ALFA.
XAB	Operate under radio readiness condition BRAVO.
XAC	Operate under radio readiness condition.
XAD	Maintain radio silence.
XAE	Maintain radar silence.
XAF	Use VHF radio only. Maintain MF/HF silence.

3. (Continued)

DARKEN SHIP

CODE	MEANING
XBA	Darken ship.
XBB	Show dimmed navigation lights.
XBC	Show shaded stern light.
XBD	Extinguish lights in excess of those ordered.

FOG

XCA	Veer fog buoy.
XCB	Recover fog buoy.

FORMATION

XDA	Form convoy formation (number).
XDB	Form emergency convoy formation (column distance in hundreds of yards) tack (ship distance in hundreds of yards).
XDC	Resume Convoy formation.
XDD	Form single line ahead.
XDE	Both wing columns are to form astern of their next inner columns (or the center column in the case of a three column convoy).
XDF	Distance between columns is to be ____hundreds of yards.
XDG	Distance between ships is to be ____hundreds of yards.
XDH	Ships ____exchange stations.

GUIDE

XEA	Take guide of the convoy and hoist large merchant ensign at masthead.

3. (Continued)

GUNNERY

CODE	MEANING
XFA	Guns may be fired for exercise or to unload them.
XFB	Escort ships will carry out exercise firing with guns or AS weapons.

IDENTIFICATION

XGA	Hoist your convoy internal call sign. (When followed by two numeral pennants, this means: Hoist your convoy internal call sign, which is).
XGB	Make your identification signal.
XGC	Show your name boards.

MOVEMENTS

XHA	Disregard my movements.
XHB	Your movements are not understood.
XHC	Follow me over the same track over the ground.
XHD	Act independently.
XHE	Proceed in execution of previous orders.
XHF	Take charge of your section.
XHG	Zig-Zag in accordance with plan ____, TACK (base course) TACK (zero time) (optional). TACK (Execution time) (optional).
XHH	Stop Zig-zagging and steer course.

POSITION

XIA	Rendezvous position is (lat), (long), (at time).
XIB	Make rendezvous in position (lat), (long), now or (time).

3. (Continued)

STATION

CODE	MEANING
XJA	Take up correct station.
XJB	Unable to keep station owing to damage.
XJC	Unable to keep station owing to mechanical defect.
XJD	Take station indicated.

MISCELLANEOUS

XKA	Switch on degaussing.
XKB	EFW is , DWD is

ANNEX D

COLORED LIGHT SIGNALS

COLORED LIGHT SIGNALS

1. Table of Special Red and Green Colored Light Signals

#	SIGNAL	FIXED OR FLASHING	MEANING
1	GN	Fixed	Wheel 20 degrees to Starboard.
	RD		
	GN	Flashing	Wheel 5 degrees to Starboard.
2	RD	Fixed	Wheel 20 degrees to Port.
	GN		
	RD	Flashing	Wheel 5 degrees to Port.
3	GN	Fixed	Resume Zigzag.
	GN		
	GN	Flashing	Stop Zigzag, resume base course.
4	GN	Fixed	Emergency turn 45 degrees to Starboard. (See paragraph 3.a.
	GN		
	RD		
5	RD	Fixed	Emergency turn 45 degrees to Port. (See paragraph 3.a.)
	RD		
	GN		
6	RD	Fixed	Disregard my movements.
		Flashing	Attack Warning, man guns.
7	RD	Fixed	Negative (if switched on at the time when a maneuve previously ordered is due to be carried out, indicates that th maneuver is cancelled and is NOT to be carried out). By sounc the special signal NO has the same signification.
	RD		
	RD	Flashing	Cancel maneuver just ordered.
8	GN	Fixed	Decrease speed 2 knots.
	RD		
	RD	Flashing	Decrease speed 1 knot.
9	RD	Fixed	Increase speed 2 knots.
	GN		
	GN	Flashing	Increase speed 1 knot.
10	RD	Fixed	Weigh Anchor.
	GN	Flashing	Anchor immediately.
11	GN	Fixed	Follow me over the same track over the ground.
	GN	Flashing	Resume previous formation, course and speed.

1. (Continued)

#	SIGNAL	FIXED OR FLASHING	MEANING
12	GN	Fixed	I am stopping my engines, maneuver to maintain station.
	RD	Flashing	Stop by backing engines, maneuver to maintain station.
13	GN	Fixed	All clear (aircraft in vicinity are friendly).
		Flashing	Leavers to part company now.

2. General Instructions

a. This system of communication has been adopted to enable the commodore to communicate at night when voice radio communications are not available.

b. All ships of the convoy will repeat the signal.

c. The time of execution is the time the signal is extinguished.

d. The lights are to be tested daily during daylight hours to ensure that they are operable.

ANNEX E

PYROTECHNIC SIGNALS

PYROTECHNIC SIGNALS

Table of Pyrotechnic Signals

LINE NO. (For reference only)	SIGNAL	SIGNIFICATION
1	ONE RED Very light	Executive Signal for an emergency turn of 45 degrees TO PORT TOGETHER
2	ONE GREEN Very light	Executive Signal for an emergency turn of 45 degrees TO STARBOARD TOGETHER
3	A SERIES of RED and GREEN Very lights fired simultaneously	Executive Signal to the ships of a convoy to SCATTER FANWISE AND PROCEED AT UTMOST SPEED
4	A series of RED and WHITE Very lights fire simultaneously	Executive Signal to the ships of a convoy to STAR and proceed at UTMOST SPEED.
5	Not less than two WHITE rockets fired in quick succession	Fired by a ship, when no other sure means of informing friendly ships and forces exist to indicate that she has been damaged by enemy action OR to indicate that enemy submarine or surface forces are in her vicinity.
6	One or more White Very lights fired from an aircraft or ship.	DANGER. Merchant ships keep clear.

Use of Pyrotechnics

a. Pyrotechnics are designed for use at night in case of extreme urgency (i.e. in the event of an emy attack), threat of enemy attack (when security of position is not of paramount importance), or hen thick weather justifies their use for maneuvering.

b. The use of pyrotechnics for maneuvering in convoy is left entirely to the Commodore's scretion, and, if used, it is for the purpose of emphasizing the urgent nature of the maneuver.

c. Owing to the possible danger of explosion from fumes, masters of vessels with dangerous rgoes should exercise their discretion in regard to the firing of rockets and pyrotechnics.

2. (Continued)

d. Independently routed merchant ships, if damaged by enemy action, between dusk and dawn, are to fire two rockets, as laid down in 501 above. These should, in good visibility, serve to attract the attention of naval ships, and aircraft, as well as warn other merchant ships in the area. Masters of independently routed ships should turn directly away upon sighting this signal.

e. A ship in convoy which sights a previously undetected enemy submarine or surface craft, or which is torpedoed, must immediately fire two white rockets in quick succession.

3. Accidental Firing

A rocket or other pyrotechnic device fired accidentally by a ship in convoy may be visible for as much as 20 miles. This gravely endangers the whole convoy. In the event of a ship firing a rocket or Very's light in error she is immediately to make the colored light signal meaning "NEGATIVE". In addition the letters NO (-.---) may be sounded on the siren. This should prevent the escort from taking the usual countermeasures against enemy attack.

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